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CALIFORNIA INLAND ANGLING SURVEY FOR 1970[1]

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This is the tenth report on California inland angling trends as determined from angler response to postal card questionnaires. Questionnaires were sent to 0.5% of the resident license purchasers in 1970. Thirty-nine percent of these were returned, amounting to a 0.2% systematic sample. Catch and effort by successful anglers were determined for trout, striped bass, sturgeon, black bass, catfish, and panfish. The numbers of successful trout, striped bass, black bass, and panfish anglers increased; numbers of successful sturgeon and catfish anglers declined. The striped bass catch increased 36%. Catches of other fishes declined.

INTRODUCTION

Trends in the California sport fish catch have been determined by angling surveys for several years since 1936. These were reported by Curtis (1940), Calhoun (1950, 1951, 1953), Skinner (1955), Ryan (1959), Seeley, Tharratt, and Johnson (1963), McKechnie (1966), and Emig (1971).

The 1970 postal card questionnaire was similar to the one used in 1969. Its basic design was described by Ryan (1959).

Angler catch and effort data for inland fishes were of primary interest. However, spaces for salmon other than kokanee salmon (*Oncorhynchus nerka*), steelhead rainbow trout (*Salmo gairdneri*), and ocean fish were provided on the cards so that anglers would separate them from the catches of inland species.

Angling surveys are designed to show trends in angling pressure and catches, and should not be interpreted as accurate accounts of total annual catch or number of days spent angling.

METHODS

The name and address of every 25th person purchasing a license were recorded by the license agents and compiled by the Department's License Section. Every seventh such licensee was mailed a questionnaire. For this survey, 10,911, or 0.5% of the resident sport fish license purchasers were mailed questionnaires. Thirty-nine percent of the cards were returned. The total sample size was about 0.2%. The sample usable for the species tables, after deletion of unacceptable returns, was 0.1% (Table 1).

A projection factor, the quotient of the number of sport fishing licenses sold divided by the usable returned questionnaires, was used to develop statewide estimates (Table 2). Only the names of resident licensees were available for the survey, and the projection factor was obtained using this total.

[1] Accepted for publication September 1972.

TABLE 1. **Characteristics of the Survey**

Item	1970	
	Number	Percentage
a. Resident sport fishing licenses sold	2,092,355	
b. Questionnaires mailed	10,911	0.52 (of a)
c. Questionnaires returned	4,282	39.24 (of b)
d. Usable returns	4,280	99.95 (of c)
e. Respondents who did not fish	262	6.12 (of d)
f. Successful respondents	3,440	80.37 (of d)
g. Unsuccessful respondents	578	13.50 (of d)
h. Projection factor	488.87	
i. Usable returns for species tables	2,532	59.16 (of d)
j. Mean days fished	18.2	
k. Number of respondents who fished for trout	2,771	64.74 (of d)

Data of these surveys are not true estimates, but are useful in indicating trends. Possible sources of sampling error and factors that partially compensate for them have been presented in previous surveys. The extent of these is unknown.

RESULTS

The results of this survey are presented in a form similar to that of previous surveys, to preserve the continuity of the series.

Certain species were grouped on the cards, because anglers often have difficulty in identifying closely related species. The "trout" category was specified on the cards as including kokanee salmon and steelhead under 1 lb. The warmwater fishes were divided into three categories: "black bass", "catfish", and "panfish". "Black bass" included largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*), redeye bass (*M. coosae*), and spotted bass (*M. punctulatus*). "Catfish"

TABLE 2. **Summary of Successful Anglers' Responses to the 1970 Statewide Angling Survey**

Item	Trout	Striped bass	Sturgeon	Black bass	Catfish	Panfish
Postal card reports	2,223	482	55	641	855	995
Successful anglers	1,087,000	236,000	27,000	313,000	418,000	486,000
Standard error	15,980	10,110	3,600	11,410	12,790	13,510
Percentage of all licensees	51.9	11.3	1.3	15.0	20.0	23.2
Mean annual catch	34.1	10.1	2.5	17.0	25.8	43.7
Standard error	1.2	0.8	0.3	1.4	2.2	2.1
Median annual catch	18.4	4.6	1.0	8.0	10.3	20.2
Total annual catch	37,058,000	2,380,000	67,000	5,327,000	10,784,000	21,257,000
Standard error	1,455,000	207,000	12,000	483,000	986,000	1,183,000
Mean annual days	10.1	10.6	8.6	10.8	10.9	9.7
Standard error	0.3	0.8	1.3	0.8	0.7	0.6
Median annual days	7.1	5.1	5.5	4.6	4.4	4.3
Total annual days	10,976,000	2,498,000	231,000	3,384,000	4,556,000	4,718,000
Standard error	364,000	223,000	46,000	282,000	324,000	305,000
Percentage of total days	41.6	9.5	0.9	12.8	17.3	17.9
Mean catch per angler day	3.4	1.0	0.3	1.6	2.4	4.5

included all catfish and bullheads (*Ictalurus* sp.), which most anglers have difficulty in distinguishing. "Panfish" included sunfish, crappie (*Pomoxis* sp.), and various fish not in other categories. Sturgeon (*Acipenser* sp.) and striped bass (*Morone saxatilis*) are not likely to be confused with other inland fishes.

Trout

Trout continued to be a favorite of California's anglers (Figure 1). In 1970, 64.7% of the respondents fished for trout (Table 1). The estimated number of successful anglers for 1970 was a new high, surpassing the 1969 figure by 8%. However, the total catch decreased by about 4% (Table 3).

TABLE 3. Trends in California Trout Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	12,000,000	149,000	50	80	50
1937	11,900,000	151,000	48	78	50
1938	12,900,000	160,000	46	79	50
1939	12,800,000	179,000	49	71	37
1941	15,700,000	238,000	53	66	40
1942	16,400,000	234,000	54	70	42
1943	15,700,000	213,000	48	75	37
1946	17,660,000	357,000	47	49	25
1948	18,400,000	415,000	43	44	20
1949	16,700,000	431,000	43	39	—
1951	18,600,000	429,000	42	43	20
1953	22,300,000	530,000	44	42	22
1954	28,600,000	578,000	47	50	22
1956	26,200,000	640,000	46	41	21
1957	30,700,000	718,000	50	43	21
1959	27,480,000	660,000	45	41	21
1960	28,000,000	709,000	48	39	21
1964	32,296,000	788,000	50	41	21
1969	38,520,000	1,006,000	52	38	18
1970	37,058,000	1,087,000	52	34	18

Striped Bass

The 1970 striped bass catch was 36% greater than in 1969, and was the second highest on record (Figure 1, Table 4). The estimated number of successful anglers was 10% greater than in 1969, and was the highest on record.

Sturgeon

Twenty-six percent fewer sturgeon were caught in 1970 than in 1969, the first year data were collected. There was also a 10% decrease in the number of successful anglers (Table 5).

Black Bass

There were 7,000 more black bass anglers in 1970 than in 1969. However, the total catch was 12% less (Table 6).

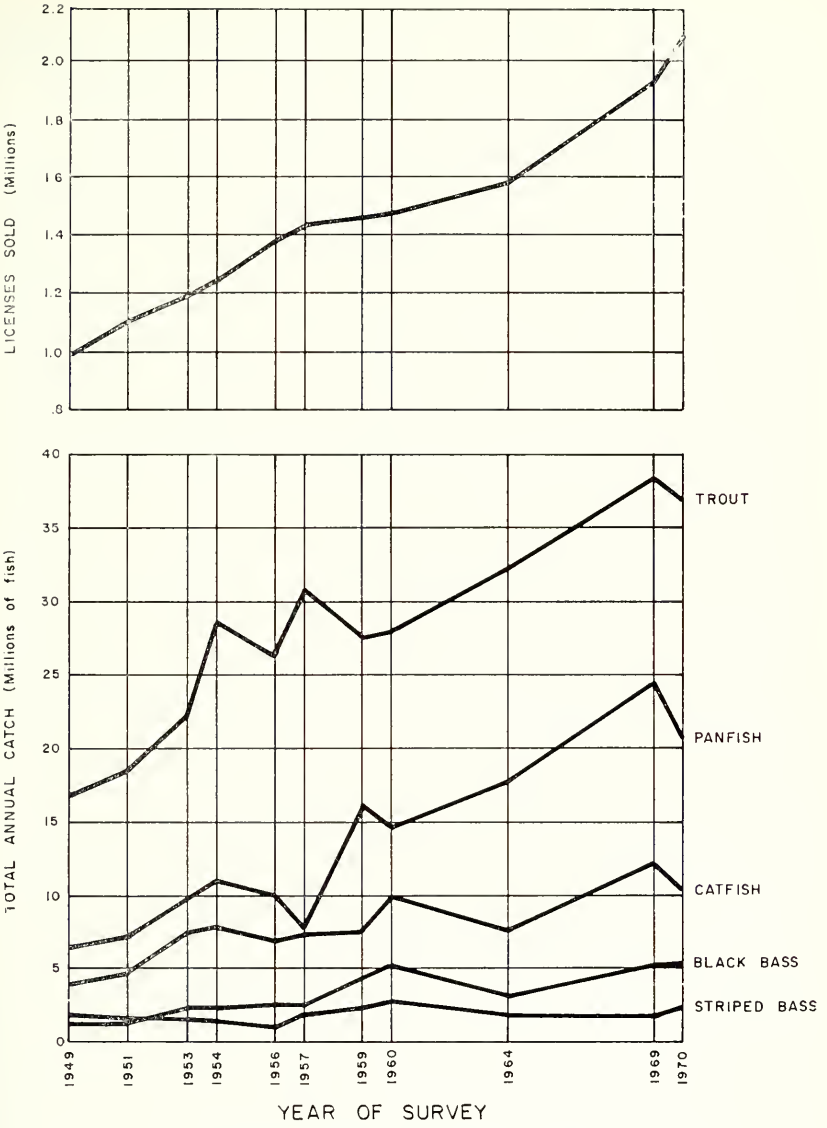

FIGURE 1. Trends in California sport fishing.

Catfish

The 1970 catfish catch was 12% less than the 1969 catch. There was a 1% decrease in the number of successful anglers (Table 7).

Panfish

The 1970 panfish catch has been exceeded only by the 1969 catch by 14%. The estimated number of successful anglers for 1970 was a new high, surpassing the 1969 figure by 5% (Figure 1, Table 8).

TABLE 4. **Trends in California Striped Bass Angling**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	2,110,000	84,400	28	25	--
1937	2,040,000	81,900	26	25	--
1938	1,940,000	92,800	27	21	--
1939	1,880,000	89,360	24	21	12
1941	1,940,000	106,900	23	18	10
1942	1,680,000	88,200	20	19	--
1943	1,680,000	75,000	17	22	9
1946	1,380,000	113,000	15	12	6
1948	1,650,000	161,000	17	10	5
1949	1,750,000	165,000	17	11	5
1951	1,490,000	144,000	14	10	5
1953	1,590,000	166,000	14	10	6
1954	1,440,000	158,000	13	9	5
1956	1,000,000	127,000	9	8	5
1957	1,890,000	230,000	16	8	5
1959	2,260,000	224,000	15	10	5
1960	2,770,000	231,000	16	12	5
1964	1,838,000	202,000	13	9	4
1969	1,747,000	214,000	11	8	4
1970	2,380,000	236,000	11	10	5

TABLE 5. **California Sturgeon Angling in 1969 and 1970**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1969	91,000	30,000	1.6	3.0	2.0
1970	67,000	27,000	1.3	2.5	1.0

TABLE 6. **Trends in California Black Bass Angling**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	930,000	34,000	11	27	--
1937	849,000	33,000	11	26	--
1938	1,190,000	46,000	13	26	--
1939	1,340,000	67,000	18	20	--
1941	1,530,000	75,000	17	20	--
1942	1,340,000	66,000	15	20	--
1943	1,570,000	79,000	18	20	--
1946	1,700,000	104,000	14	16	--
1948	1,890,000	128,000	13	15	6
1949	1,160,000	116,000	12	10	5
1951	1,280,000	108,000	11	12	6
1953	2,300,000	161,000	14	14	9
1954	2,300,000	154,000	12	15	8
1956	2,550,000	164,000	12	16	9
1957	2,440,000	179,000	12	14	8
1959	4,493,000	218,000	15	20	9
1960	5,150,000	235,000	16	22	9
1964	2,992,000	217,000	14	14	8
1969	6,067,000	306,000	16	20	9
1970	5,327,000	313,000	15	17	8

TABLE 7. **Trends in California Catfish Angling**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	2,940,000	38,000	13	78	--
1937	2,810,000	43,000	14	65	--
1938	3,480,000	48,000	14	72	--
1939	4,333,000	75,000	20	58	--
1941	6,100,000	97,000	21	63	--
1942	8,250,000	110,000	25	75	--
1943	7,060,000	101,000	23	70	--
1946	6,530,000	149,000	19	44	--
1948	5,560,000	182,000	19	31	15
1949	3,930,000	161,000	16	24	12
1951	4,710,000	171,000	17	29	12
1953	7,500,000	225,000	19	33	15
1954	7,990,000	220,000	18	37	13
1956	6,970,000	217,000	16	32	10
1957	7,370,000	259,000	18	28	13
1959	7,674,000	232,000	16	32	10
1960	10,100,000	275,000	19	37	15
1964	7,684,000	284,000	18	27	11
1969	12,319,000	422,000	22	29	10
1970	10,784,000	418,000	20	26	10

TABLE 8. **Trends in California Panfish Angling**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1954	10,970,000	205,200	17	53	26
1956	10,020,000	225,000	16	44	18
1957	7,680,000	244,000	17	31	17
1959	16,114,000	281,000	19	56	22
1960	14,740,000	296,000	20	50	22
1964	17,793,000	326,000	21	55	20
1969	24,668,000	463,000	24	53	22
1970	21,257,000	486,000	23	44	20

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Calif. Fish and Game, 59(2) : 107–113. 1973.

FISH SPECIES DIVERSITY IN A PREHISTORIC CENTRAL CALIFORNIA INDIAN MIDDEN[1]

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The relative prehistoric abundance of native fish species was investigated by analyzing remains from an aboriginal fishing site in southern Sacramento County, California. The remains of at least 804 fish were examined. Sacramento perch was the most abundant species (51.0%), followed by Sacramento hitch (20.0%) and thicktail chub (12.4%). Nine other species were recorded. The fauna is characteristic of a lacustrine environment, and marked differences from the present day fauna are noted.

INTRODUCTION

Biologists have noted marked changes in the fish fauna of California in recent times. During the mid 1800's, lumbering activities and hydraulic mining caused heavy siltation of central California rivers. These activities were quickly followed by swamp drainage and land reclamation in the Sacramento-San Joaquin Delta as well as construction of dams on many of the major tributaries of the Sacramento-San Joaquin system. During the last 100 years, exotic fish species have been introduced from the eastern United States and Eurasia. All of these factors have combined to produce radical changes in the composition of the freshwater fish fauna of the State.

The freshwater fishes of California have been studied for more than a century but quantitative data are scarce for native forms before the alterations caused by the Euroamerican occupation. This paper presents a quantitative study of the fish remains from a prehistoric aboriginal fishing village in the lower Sacramento Valley.

SITE

The Stone Lake site (4-Sac-145) is a prehistoric Indian midden situated on the south shore of Stone Lake, 2 miles east of the Sacramento River and 3.5 miles southwest of Franklin in southern Sacramento County, California. It lies on the northern periphery of the Sacramento-San Joaquin Delta. At present, Stone Lake is a shallow, marshy, landlocked lake surrounded by levee-protected farmlands. Except for more frequent seasonal flooding in the absence of levees, much the same situation appears to have existed prehistorically. Radiocarbon dates on charcoal and human bone indicate an occupation from roughly 1,000 to 200 years before the present. Excavations at this site were conducted in the spring of 1971 under the direction of William Pritchard of the Cultural Resources Section, California Department of Parks and Rec-

[1] Accepted for publication December 1972.

reation. The site was scheduled for destruction by canal construction, and was investigated as an archaeological salvage effort under a contract with the California Department of Water Resources.

The site lies within the historic territory of the Cosomne tribelet of the Plains Miwok (Bennyhoff 1961). Tribelets in this area of California consisted of one or two major villages and the territory claimed and utilized by their inhabitants, including minor villages or camps (such as the Stone Lake site) occupied for various economic tasks. The subsistence base of these people depended upon fishing, plant gathering, and hunting; probably in that order of importance. No domestic plant or animal species were known other than the dog.

METHODS

Eleven 2-by-2-m units were selected at random for examination of fish remains. Depth provenience was maintained by arbitrary 10 cm levels. Three shallow units peripheral to the site proper produced no identifiable fish bone. The remaining eight units ranged in depth from 60 to 110 cm. Total volume of the bone-bearing units was 24.4 m^3, representing about 1.5% of the midden deposit.

All earth from the units was passed through $\frac{1}{8}$-inch mesh screens and washed. The recovered material was returned to the laboratory. Fish remains were extracted and identified to species level whenever possible. The minimum number of individuals present was established by counting the most abundant element (index element) for each species. Exact provenience was retained for all data collected (see Simons and Schulz, 1972, for a complete listing of these data).

RESULTS

Twelve species of fishes totaling 804 individuals were represented in the material examined (Table 1). The large number of burned vertebrae and other bones encountered indicated that the remains were the result of cultural activity and did not represent a natural deposit. No significant variations in species diversity were noted as existing between the various levels of the midden.

TABLE 1. **Frequency of Occurrence and Index Element of Fish Species in the Stone Lake Midden.**

Species	Common name	Index element	Individuals
Archoplites interruptus	Sacramento perch	Left otolith	410
Lavinia exilicauda	Hitch	Left pharyngeal	161
Gila crassicauda	Thicktail chub	Left pharyngeal	100
Pogonichthys macrolepidotus	Splittail	Right pharyngeal	50
Catostomus occidentalis	Sacramento sucker	Right dentary	47
Orthodon microlepidotus	Sacramento blackfish	Right pharyngeal	12
Hysterocarpus traski	Tule perch	Lower pharyngeal	10
Mylopharodon conocephalus	Hardhead	Pharyngeals	6
Ptychocheilus grandis	Sacramento squawfish	Left pharyngeal	5
Oncorhynchus tshawytscha	King salmon	Left otolith	2
Cottus sp.	Sculpin	Otoliths	1
Acipenser sp.	Sturgeon	Dermal scutes	(present)
Total			804

Both the artifacts and the bone recovered show that the midden represents a large fishing station. Since many fish species have marked habitat preferences, it was assumed that they would form a sensitive index of environmental conditions at the site during the period of occupation.

Sacramento Perch (*Archoplites interruptus*)

This species accounted for 51.0% of the fish in the sample. This is in contrast to its present scarcity in the area and confirms reports that it has declined sharply in abundance over the last 100 years. Turner (1966*b*) and Tharratt and McKechnie (1966) reported that Sacramento perch concentrate in quiet sloughs off the main channels. Rutter (1908) charged its decline to the reclamation of wetlands and the introduction of carp and catfish. Neale (1931) supports this and notes that before the introduction of these forms *Archoplites* held its own even with extensive market catches. Six species of introduced sunfish reported by Turner may also be among the competitors and predators contributing to the reduction of this once dominant form.

Hitch (*Lavinia exilicauda*)

Hitch was the second most abundant species at 4-Sac-145 (20.0%). Predominantly an inhabitant of sloughs and slow water (Murphy 1948), it is found in other zones as well (Turner 1966*c*). The hitch makes extensive spawning migrations. It was thought to require fast streams and gravel bottoms for spawning until Kimsey (1960) demonstrated that spawning may take place in soft bottomed ponds and lakes with no stream access.

Thicktail chub (*Gila crassicauda*)

This species is now probably extinct, but the Stone Lake data demonstrate that it once formed a major part of the native freshwater fish fauna of California. It comprised 12.4% of the midden sample. According to Miller (1963), it inhabited lowland streams, overflow ponds, marshes and lakes in the Sacramento-San Joaquin Valley. Its decline took the form of a rapid reduction in numbers apparently resulting from 19th and 20th century land reclamation and from competition from introduced species.

Splittail (*Pogonichthys macrolepidotus*)

Splittail was the fourth most abundant form recovered from the site (6.2%). Turner (1966*c*) found this species at every sampling location during his study of Delta cyprinids. It is thus one of the most evenly distributed cyprinid fishes and is found in a variety of environments.

Sacramento sucker (*Catostomus occidentalis*)

This species accounted for 5.8% of the midden sample. Like the splittail, the Sacramento sucker also seems to occupy a number of aquatic environments, inhabiting both streams and lakes. It migrates upstream during the spring and early summer to spawn. Spawning is believed to take place only in streams over gravel riffles (Burns 1966*a*).

Sturgeon (*Acipenser* sp.)

Sturgeon were represented in the midden material by abundant dermal scutes and scute fragments. Since there is no practical means of establishing minimum numbers from these elements, they were recorded but not quantified. From the frequency of the scutes, it is suspected that this was probably the sixth most abundant form. Two species of this genus are native to central California, white sturgeon (*A. transmontanus*) and green sturgeon (*A. medirostris*). White sturgeon appear to frequent open channels and estuarine bays for most of their life cycle (Lee W. Miller, Dep. of Fish and Game, pers. comm.). Use of the lower Sacramento system by green sturgeon is less clear.

Other Species

Six other fishes were found in the midden: tule perch (*Hysterocarpus traski*), Sacramento blackfish (*Orthodon microlepidotus*), Sacramento squawfish (*Ptychocheilus grandis*), hardhead (*Mylopharodon conocephalus*), sculpin (*Cottus* sp.), and king salmon (*Oncorhynchus tshawytscha*). Combined they equalled only 4.6% of the calculated number of individuals. Of these species, Rutter (1908) reports that tule perch prefer sluggish waters, as does the Sacramento blackfish, which avoids even moderately swift water (Murphy 1950).

The remaining fish species from the midden are often associated with open rivers. This is the case with the Sacramento squawfish (Turner 1966*c*; Burns 1966*c*) and the hardhead (Burns 1966*b*). Squawfish may also occupy lowland lakes and sloughs (Taft and Murphy 1950). Sculpin prefer the cooler waters of Central Valley rivers (Kimsey and Fisk 1964), while king salmon is a main current anadromous species which migrates upstream in the spring and fall to spawn.

The fish present at 4-Sac-145 can be divided into three categories by their ecological requirements. The first category comprises forms preferring sloughs, low-lying lakes and ponds, overflow basins and marshes. It includes the Sacramento perch, hitch, thicktail chub, Sacramento blackfish, and tule perch. The second group is composed of species which inhabit a wide variety of environments: the splittail, Sacramento sucker, and squawfish. Finally, there are the main channel forms represented by the hardhead, salmon, sculpin, and sturgeon.

Since 86.2% of the total calculated individuals from the midden prefer slow water (Figure 1), it is likely that the aquatic environment in the vicinity of the site during aboriginal occupation was similar to that present today (i.e., a low-lying, marshy lake). The moderate abundance of generalized forms (12.7%) does not conflict with this conclusion. Mainstream species (excluding sturgeon) comprise only 1.1% of the total. The scarcity of these forms provides sufficient evidence that they are ecologically intrusive. (The absence of other swift water species such as trout and lamprey is noteworthy.) Salmon occasionally reach adult size in landlocked lakes (McAfee 1966), and the overflow lakes of the lower Sacramento drainage formerly did contain populations of sturgeon, salmon, and other mainstream fish stranded by receding winter flood waters (Shapovalov 1947).

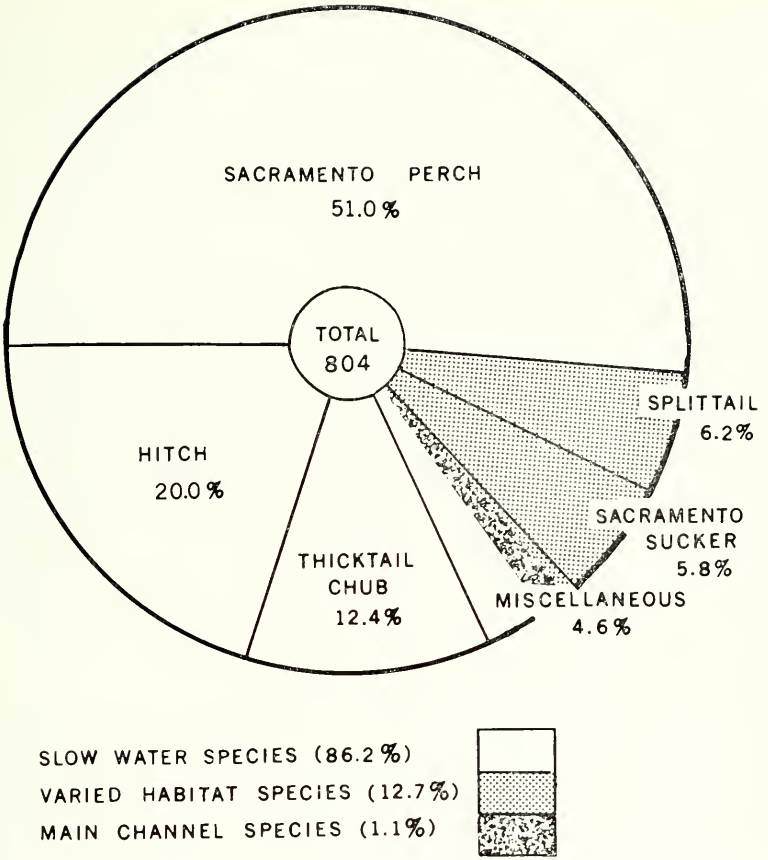

FIGURE 1. Circle graph representing the relative abundance of the major fish species in the Stone Lake midden. The six species included in the 'miscellaneous' category are listed in Table 1. The total of 804 individuals excludes sturgeon.

DISCUSSION

Some danger is inherent in relying upon a single sampling technique to indicate even relative population densities. This is especially the case with prehistoric faunas since it is often impossible to determine the processes responsible for their deposition. At Stone Lake fish were probably taken primarily with seines and to a lesser extent with other kinds of nets. There is little artifactual or ethnographic evidence for line fishing or bow and harpoon use except as incidental techniques.

Although some native northern Californians, such as the Wintu on the upper Sacramento and McCloud rivers, rejected fish other than salmon and steelhead as food items (DuBois 1935), this does not appear to have been the case in the lower Sacramento-San Joaquin area. Among the Patwin of the Lower Sacramento, for example, certain families specialized in obtaining fish from sloughs and lakes (McKern 1922), and the Stone Lake site may represent the camp of such

a group of relatives. There is no evidence of selection against any of the native fish species for food by these fishermen. Thus, all species were probably utilized as caught and taken in numbers roughly equivalent to their relative abundance. Since there is no evident change in species composition throughout the approximately 800 years the site was occupied, the diversity appears to have been stable during that period and not merely characteristic of a single catch. Therefore, the above analysis probably presents a reliable index to the species composition in prehistoric stillwater environments of the lower Central Valley of California.

The prehistoric species diversity shows marked contrast with the present day fauna, resulting from 19th and 20th century introductions of exotic species. Stone Lake itself now contains 13 species of fish, only one of which (Sacramento blackfish) is native (J. Staley, Dep. Fish and Game, unpublished data). Sacramento perch and hitch, which now are uncommon in the Delta (though they retain larger populations elsewhere), were formerly the most abundant slow water forms; the thicktail chub, now probably extinct, was the third most abundant species in the prehistoric fauna. These numerically dominant species have now been replaced by various forms of catfish (Turner 1966*a*) and centrarchids (Turner 1966*b*). Tule perch and Sacramento blackfish are relatively scarce in the Delta today. Our data suggest that this situation prevailed prehistorically as well. The other forms were no doubt more common in open channel environments.

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Calif. Fish and Game, 59(2) : 114–120. 1973.

MATURATION AND GROWTH OF PACIFIC MACKEREL, *SCOMBER JAPONICUS* HOUTTUYN[1]

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The maturation of Pacific mackerel has never been documented clearly. Analysis of data reveals spawning can occur from March through October, but the majority takes place from April through August. During this April through August period, 22.5%, 65.7%, 75.1%, 84.7%, 84.2%, and 87.5% of the female fish were mature or maturing for Age Groups I, II, III, IV, V, and VI+ respectively.

A von Bertalanffy growth curve and a weight-length curve were calculated. The weight-length curve differed significantly from a curve previously published.

INTRODUCTION

The biology of Pacific mackerel must be clearly understood to properly manage this resource. One of the aspects of its biology which has not been clearly documented in the literature is age at first spawning. Fry (1936) states that yearling fish do not spawn, whereas most of the 2-year olds do. Fitch (1952) observed that most mackerel do not spawn until their third or fourth year.

To clearly document age at maturity, we conducted a special study on the maturation and growth of Pacific mackerel. This information will contribute to our understanding of the biology and population dynamics of this fish.

METHODS

Maturation Data

Data concerning 1958–59 through 1969–70 Pacific mackerel seasons were utilized to determine age at maturity. Information from 3,397 female Pacific mackerel was used in the study. Samples were taken as part of a program for monitoring the California commercial mackerel catch.

Three maturity stage categories were established. If eggs were not visible with the naked eye, fish were considered immature (Stage i). If a fish had unripe yellowish eggs visible to the naked eye, it was considered to be developing (Stage g). Any fish which had large transparent ripe eggs was classified as mature (Stage G). This maturity index agrees favorably with that suggested by Holt (1959) for *Rastrelliger* (Table 1).

[1] This study was conducted in cooperation with the Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, under Public Law 88-309, Project 6-3-R. Accepted for publication August 1972.

Growth Data

Weight-length relationships were determined by using a computer program (Abramson, 1971) which fits weight-length data to the exponential curve: $W = aL^b$

where: W = weight
L = length
a = constant
b = constant

A computer program also was used to fit Pacific mackerel data to the von Bertalanffy growth equation: $l_t = L\infty\ [1 - \exp\ (-kt + kt_o)]$.

where: l_t = total length at age t
$L\infty$ = maximum expected length
t_o = fitted length at age zero, extrapolated backward from growth pattern in later life
k = a parameter related to the metabolic rate
exp = exponential function

This program fits a curve using the least squares procedure with weights proportional to sample size (Tomlinson and Abramson, 1961).

TABLE 1. **Maturity Stages of *Rastrelliger* and *Scomber***

Extent of ovary in body cavity	General appearance of ovary	*Rastrelliger** Stage and state	*Scomber* stage
About ⅓ length of cavity---	Translucent; reddish to pinkish ova invisible to naked eye	I Immature	i
About ½ length of cavity---	Translucent; pinkish color; ova invisible to naked eye	II Mature virgins and recovering spents	i
About ⅔ to full length of cavity	Pinkish yellow color; granular opaque appearance; ova entirely opaque; no translucent or transparent ova visible	III Ripening	g
From ⅔ to full length of cavity	Orange to pink color; superficial blood vessels; conspicuous large translucent to transparent ripe ova visible; eggs might be extrusable	IV Ripe	G
Shrunken to about ½ length of cavity; walls loose	Remnants of disintegrating opaque and ripe ova visible; may be darkened or translucent	V Spent	--

* From Holt, 1959.

RESULTS

Maturation

Analysis of data indicates spawning can occur from March through October, but the majority takes place from April through August. An important factor contributing to the great spread in spawning time is that eggs of an individual fish appear to mature in successive batches. Ripe translucent eggs appear irregularly in the ovary amongst still unripe ova in early stages of development. This condition also has been found in Atlantic mackerel, *Scomber scombrus* Linnaeus, (Steven, 1949) and in *Rastrelliger* (Holt, 1959).

Only five fish were found in a spent condition during the entire study and all of these in October. Since eggs mature in successive batches, a spent condition would not be found in a fish until all spawning was completed. Due to this fact, we did not include spent condition in our maturity stage classification (Table 1).

All identification and examination of ovaries was done externally; therefore, the number of mature fish may have been underestimated. Steven (1949) found that Atlantic mackerel ovaries containing numerous ripe eggs in the lumen may show no external evidence of their presence.

Immature individuals were found in each age group throughout the year (Table 2). No female Pacific mackerel spawn during their first season (Age Group O), and only 22.5% of Age Group I fish were mature or maturing from April through August (Table 3). During this same period, the maturation in older age groups was 65.7%, 75.1%, 84.7%, 84.2% and 87.0% for Age Groups II, III, IV, V, and VI+ respectively. It is not definite that all individuals of any age group spawn in any given season, and the percentage of maturation is higher during some months than for the spawning season (Table 4).

We also conducted a study on maturity of male Pacific mackerel; however, our results should be considered preliminary because of the small sample size (205). Male Pacific mackerel mature earlier in life than females and appreciable amounts of ripe sperm commonly are found. No Age Group O males were mature or maturing. During a 3-month period (May through July), the male fish mature or maturing was 88.0%, 96.6%, 100.0%, 100.0%, 100.0%, 100.0% for Age Groups I, II, III, IV, V, and VI+ respectively.

Growth

We processed lengths and weights of 1,232 fish with the resultant weight-length relationship for Pacific mackerel being $W = 0.0000013660\ L^{3.39358}$. Using this formula, a 270 mm FL fish weighs 243 g (Table 5) while a 340 mm FL fish weighs 532 g. The calculated length-weight curve is a good fit for the data with the correlation coefficient being 0.994 (Table 6).

Traditionally Pacific mackerel measurements have been reported in quarter-centimeters. To facilitate future workers who may use this measurement with the exponential equation $W = aL^b$, the constant a should be changed to 3.06119E-05 while the constant b of 3.39358 remains the same number.

The weight-length curve was compared to the curve determined by D. H. Fry, Jr. (Fitch, 1951). An analysis of covariance was calculated from the resulting two lines of a log transformation. There was no significant difference between the slopes of the two lines; nevertheless, there was a significant difference in elevations and variation about the regression lines (all differences at the 99% significance level). The older set of data showed more variation about the regression line.

The von Bertalanffy growth curve estimate for Age Group I fish was 273 mm FL (Table 7), while the estimate for Age Group III was 336 mm FL. The maximum expected length ($L\infty$) was calculated to be 436 mm FL (Table 8). These estimates are derived from data taken throughout the season and represents mean size at midseason for each age group.

TABLE 2. **Monthly Maturity Index of Pacific Mackerel in Percent**

Months	Age group						
	O	I	II	III	IV	V	VI+
January							
i	--	100	100	100	95	94	100
g	--	--	--	--	5	6	--
G	--	--	--	--	--	--	--
February							
i	--	100	100	83	78	50	100
g	--	--	--	17	22	50	--
G	--	--	--	--	--	--	--
March							
i	--	97	84	50	25	20	34
g	--	3	16	45	75	80	67
G	--	--	--	5	--	--	--
April							
i	--	76	28	16	4	5	24
g	--	21	69	72	91	90	70
G	--	3	3	12	5	5	6
May							
i	--	78	34	13	2	9	--
g	--	22	66	78	82	61	64
G	--	--	--	9	16	30	36
June							
i	--	77	16	25	23	23	14
g	--	23	82	72	60	77	71
G	--	--	2	3	17	--	15
July							
i	--	72	33	28	18	39	7
g	--	28	65	72	82	61	67
G	--	--	2	--	--	--	26
August							
i	100	86	76	55	36	17	25
g	--	14	24	41	43	44	25
G	--	--	--	4	21	39	50
September							
i	100	89	75	54	74	83	56
g	--	11	25	46	26	17	44
G	--	--	--	--	--	--	--
October							
i	100	99	94	75	87	99	70
g	--	1	6	25	12	1	30
G	--	--	--	--	1	--	--
November							
i	100	100	100	100	96	100	95
g	--	--	--	--	4	--	5
G	--	--	--	--	--	--	--
December							
i	100	100	100	100	100	100	100
g	--	--	--	--	--	--	--
G	--	--	--	--	--	--	--

TABLE 3. **Maturity Index of Female Pacific Mackerel in Percent for April Through August**

Months	Age group						
	0	I	II	III	IV	V	VI+
April–August							
i	100	77.5	34.3	24.9	15.3	15.8	13.0
g	--	22.2	64.5	69.9	73.1	64.2	64.8
G	--	0.3	1.2	5.2	11.6	20.0	22.2
Percent mature or maturing	0.0	22.5	65.7	75.1	84.7	84.2	87.0
Number examined	45	613	318	173	190	120	54

TABLE 4. **Highest Percentage of Mature and Maturing Stages of Female Pacific Mackerel in Any One Month**

Age group	Percentage	Month	Number examined
I	28	July	137
II	84	June	82
III	87	May	46
IV	98	May	44
V	95	April	20
VI+	100	May	11

TABLE 5. **Some Expected Weights for Given Lengths by 10 mm FL Groupings**

Fork length (mm)	Expected weight grams	Fork length (mm)	Expected weight grams	Fork length (mm)	Expected weight grams	Fork length (mm)	Expected weight grams
130	20	220	122	310	389	400	924
140	26	230	141	320	433	410	1005
150	33	240	163	330	481	420	1090
160	41	250	188	340	532	430	1181
170	51	260	214	350	587	440	1277
180	62	270	243	360	646	450	1378
190	74	280	275	370	709	460	1485
200	88	290	310	380	776	470	1597
210	104	300	348	390	848	480	1716

TABLE 6. **Constants and Standard Errors for the Weight-Length Relationship**

a	b	Standard error of b	Standard error of the estimate	Correlation coefficient
1.36600E-06	3.39358	0.01088	39.04692	0.994

DISCUSSION

Population size may account for the relative rate of growth. Davidson and Vaughan (1941) suggested that more abundant populations of pink salmon, *Oncorhynchus gorbuscha* (Walbaum), are slower growing. Witney (1961) found that growth rates of bairdiella, *Bairdiella icistius* (Jordan and Gilbert), in the Salton Sea, California, decreased as the population increased.

MacGregor (1959) found that low population levels of Pacific sardine are associated with high condition factors and, conversely, high population levels are associated with lower condition factors. The inverse correlation was interpreted as a cause and effect relation; that is, high population levels result in less available food per fish and low condition factors, while low population levels result in more available food per fish and higher condition factors.

TABLE 7. **Lengths at Various Ages**

Age	Fitted length (mm FL)	Sample mean length (mm FL)	Standard error of sample mean	Sample size
I	272.96	272.44	1.121	349
II	308.34	312.35	1.113	119
III	336.05	334.75	0.789	157
IV	357.75	356.09	0.927	172
V	374.75	375.52	0.675	232
VI	388.05	388.52	1.242	108
VII	398.48	396.80	1.623	57
VIII	406.64	412.27	3.653	11

Standard error of estimate = 14.8762.

TABLE 8. **Estimates of Parameters for Von Bertalanffy Growth Curve**

	Parameters average maximum length cm/4	Parameters average maximum length mm	Metabolic rate constant k	Fitted length at age zero to
Estimates	174.45	436.12	0.244440	−3.0222
Standard errors	2.10	5.26	0.13694	0.154625

In Pacific mackerel, the population decreased in biomass from a high during the 1931 to 1933 period to a low during the 1966 to 1970 period. The estimated total biomass for I year-old fish and older during the 1931 to 1933 period ranged from 1,040,519,000 to 1,593,966,000 lb. The total biomass estimates for the 1966 to 1970 period ranged from 6,728,000 to less than 1,101,000 lb. If at this later period there was a decrease in the competition within the population, then certainly the weight at size could increase.

A comparison was made between Murphy method estimates of recruits at age I and mean size at age I for 29 consecutive years. The results show little correlation between estimated numbers of recruits and mean size at age I ($r = -0.208$).

Witney (1961) found that bairdiella matured later in life as the population increased and growth rates decreased. In Pacific mackerel, if growth by weight at size has increased, then this may account for the apparent increase in maturation at an earlier age.

The two studies were done over 30 years apart. An environmental or growth change may have occurred; however, the true reason for these apparent changes may be based on the manner in which the data was collected. The older data was collected only intermittently during the study period, while the newer set of data was collected throughout the year.

CONCLUSIONS

Most female Pacific mackerel (65.7%) are mature or maturing by their third year of life (Age Group II). The percentage of fish maturing continues to increase from age at first spawning until Age Group IV where it levels off at a high percentage of fish maturing within a spawning season.

The Pacific mackerel sampled during the 1966 to 1970 period had a larger mean weight at size than those fish sampled from 1931 to 1933. Fish sampled from 1958 to 1970 also appeared to mature earlier in life than those caught during the early years of the fishery.

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AGE AND LENGTH COMPOSITION OF NORTHERN ANCHOVIES (*ENGRAULIS MORDAX*) LANDED IN CALIFORNIA FOR REDUCTION DURING THE 1970–71 SEASON[1]

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Anchovy landings totaled 80,752 tons during the 1970–71 season. Catch estimates were not calculated from central California landings due to a lack of data. Age groups I, II and III accounted for 92% of the catch in southern California.

INTRODUCTION

This is the fourth in a series of reports on age and length composition of northern anchovies landed for reduction in California. Data presented cover 1970–71 anchovy season landings (August 1, 1970–May 15, 1971). Methods of sampling, age determination, and estimation of numbers and weights are the same as those used during the 1969–70 anchovy season (Collins, 1971).

The two fishing areas, central and southern California (Messersmith, 1969), produced 80,752 tons. Catch estimates were not calculated for central California due to insufficient data. Catch estimates for southern California were calculated from San Pedro landings which totaled 87% of southern California landings (Table 1). The remaining 13% were landed at Port Hueneme. A total of 412 samples was taken, and 5,043 fish were processed.

SIZE AND AGE COMPOSITION

Anchovies sampled from southern California ranged from 77 mm to 169 mm SL. Length groups 105–134 mm SL comprised 77% of the estimated 3 billion fish landed at San Pedro (Table 2). Anchovies smaller than 105 mm SL dropped from 10.6% in the 1969–70 season catch (Spratt, 1972) to 1.50% this season. This was due to reduced fishing pressure in the spring of 1971 when the incoming year class was recruited to the fishery.

The 1970–71 season was dominated by age group II fish, comprising 40% by number and 42% by weight of the catch (Table 3). Age groups I, II, and III combined accounted for 92% of the catch in both number and weight. This is slightly higher than the 1969–70 season when age groups I, II, and III represented 90% of the catch (Spratt, 1972).

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TABLE 1. **Tons of Anchovies Landed for Reduction by Area 1970–71 Season**

Area	Tons	Percent
Southern California		
San Pedro	69,621	86.2
Port Hueneme	10,474	13.0
Central California		
Moss Landing	657	0.8
Total	80,752	100.0

TABLE 2. **Estimated Number of Anchovies Landed in Southern California for Reduction by Length Group, 1970–71 Season**

Length mm SL	Estimated number	Standard deviation	Percent
75– 84	1,077,500	1,144,080	.04
85– 94	1,737,500	1,224,049	.06
95–104	42,258,500	7,435,014	1.40
105–114	257,050,000	21,767,808	8.52
115–124	910,197,000	31,352,923	30.16
125–134	1,156,554,000	25,241,423	38.32
135–144	504,967,000	19,836,548	16.73
145–154	123,271,000	9,891,845	4.08
155–164	19,417,000	3,457,003	.64
165–174	1,223,500	872,770	.04
Total	3,017,753,000	--	99.99

SEX RATIOS

Sex ratios have varied widely from season to season in the southern California anchovy reduction fishery; 1.6 females to 1 male in 1966–67, 1.4:1 in 1968–69, and 1.1:1 in 1969–70. The 1970–71 sex ratio is no exception. Sample data yielded a ratio of 1.6:1 and a weight ratio of 1.7:1 (Table 4).

TRENDS IN AGE COMPOSITION

Age data have been collected since the 1965–66 anchovy reduction season. These data have been compared for southern and central California, and the following trends are noticeable.

Southern California

A gradual but decided shift from age groups I, II, and III to age groups 0, I, and II is demonstrated by percentage age composition of the catch from the 1965–66 through the 1969–70 season (Table 5). This shift primarily was due to increased fishing effort in the spring when young of the year reach legal size (108 mm TL). Increased spring fishing effort coupled with apparent large year classes produced the past 3 years have resulted in more young fish caught. During the 1970–71 season, there was very little spring fishing effort, and the catch age composition reverted back to primarily age groups I, II, and III.

Northern California

The age composition of the catch has shifted from predominantly age groups III and IV in the 1966–67 season to age groups I and II in the 1969–70 season (Table 6). The absence of age groups V and VI in the 1969–70 season occurred by chance. Preliminary data from the 1971–72 season indicate these age groups are represented.

CONCLUSIONS

The experimental anchovy reduction fishery authorized by the California Fish and Game Commission in 1965 has had no deleterious effects on the northern anchovy population in the California Current System. Age and length data collected during each of the six anchovy reduction seasons indicate a healthy and viable population. Age groups I and II have dominated the catch consistently in southern California. While anchovy landings in central California have declined the past four seasons, catch estimates indicate a healthy population. The decline of the central California fishery is due to socioeconomic rather than biological reasons.

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I wish to express my sincere thanks to those people who participated in collecting and analyzing the data. Gayland S. Taylor collected and processed samples from southern California. Stephen J. Crooke spent many long hours at the microscope reading otoliths. Catherine Berude handled the computer operations. Herbert W. Frey offered editorial assistance.

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TABLE 3. **Estimated Number and Weight of Anchovies Landed in Southern California for Reduction by Age and Year Class, 1970–71 Season**

Age	O	I	II	III	IV	V	VI	Total
Year class	1970	1969	1968	1967	1966	1965	1964	
Number	122,461,000	970,000,000	1,211,950,000	606,187,000	92,056,000	14,535,500	563,500	3,017,753,000
Standard deviation	16,559,784	32,755,345	22,393,337	18,464,659	7,642,687	2,876,840	563,630	--
Percent of landings	4.06	32.14	40.16	20.09	3.05	.48	.02	100.00
Weight in pounds	3,667,000	38,159,500	57,984,000	32,445,500	5,923,500	1,034,500	28,000	139,242,000
Standard deviation	470,961	1,212,396	1,091,668	1,023,606	503,534	207,595	27,834	--
Percent of landings	2.63	27.41	41.64	23.30	4.25	.74	.02	99.99

TABLE 4. **Sex Ratio of Catch in Numbers and Pounds, Southern California 1970–71 Season**

Sex	Estimated number	Standard deviation	Percent	Females: males	Estimated pounds	Standard deviation	Percent	Females: males
Male	1,114,249,500	25,722,369	36.9		48,899,000	1,091,051	35.1	
Female	1,781,373,500	25,109,847	59.0	1.6:1	85,520,000	1,169,013	61.4	1.7:1
Unknown	122,130,000	12,747,802	4.0		4,823,000	482,903	3.5	
Total	3,017,753,000		99.9		139,242,000		100.0	

TABLE 5. **Estimated Percentage Age Composition by Number of the San Pedro Anchovy Catch, 1965–66 Through 1970–71 Reduction Season**

Season	Age					
	O	I	II	III	IV	V+
1965–66	4.48	14.72	48.51	23.37	7.46	1.44
1966–67	6.87	22.92	38.13	23.00	7.51	1.53
1967–68*	----	----	----	----	----	----
1968–69	18.54	45.89	22.39	8.17	4.31	0.70
1969–70	26.98	27.83	35.23	8.27	1.53	0.16
1970–71	4.06	32.14	40.16	20.09	3.05	0.50

* There were no San Pedro landings this season.

TABLE 6. **Estimated Percentage Age Composition by Number of the Central California Anchovy Catch, 1965–66 Through 1970–71 Reduction Season**

Season	Age						
	O	I	II	III	IV	V	VI
1965–66*	----	----	----	----	----	----	----
1966–67	0.32	5.87	17.01	40.76	26.86	8.86	0.28
1967–68	1.40	12.69	26.31	30.68	19.25	9.09	0.55
1968–69	8.96	20.57	29.70	20.81	12.09	4.34	3.53
1969–70	2.59	30.83	45.67	17.12	3.78	----	----
1970–71*	----	----	----	----	----	----	----

* Insufficient data collected to compute catch estimates.

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WILD PIGS IN MONTEREY COUNTY, CALIFORNIA[1]

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Information on the status of wild pigs (*Sus scrofa*) in Monterey County was collected from 1964 through 1968. A total of 138 pigs was trapped, tagged and released on Hunter Liggett Military Reservation, in Carmel Valley, and Big Sur State Park. Of the tagged pigs, 53 were retrapped, and the average distance traveled was 0.2 mile. Tags from 29 hunter-killed pigs were returned. The average distance from the release site was 2.6 miles.

Pigs have a gestation period of about 4 months. Some farrowing occurred during every month of the year; however most farrowing was from October through June, with the peak in March. The average litter size was 4.2.

After the 1966–67 hunting season, a poor forage production year, the estimated county-wide population was 1,622 (1.3 pigs per square mile). After the 1967–68 season, an excellent forage production year, the estimated pig population was 2,600 (2.1 pigs per square mile).

Hunting mortality on Hunter Liggett Military Reservation accounted for 9% of the on-base population in 1966–67 and 19% in 1967–68. Of the pigs killed in the 1967–68 season, 80% were less than 26 months old.

In 1966 the average weight gain for 64 pigs was 0.20 lb. per day. In 1967 the average weight gain for eight pigs was 0.11 lb. per day.

Grasses and acorn mast were the important foods throughout the year. Forbs were important when available. Other noteworthy foods were miscellaneous animal items including earthworms and carrion; and, California bay fruits, lily bulbs, corms and roots. Management implications are discussed.

INTRODUCTION

The original stock of European wild pig in the United States was brought from the Ural Mountains in Russia to Hoopers Bald, North Carolina, in 1912 (Jones 1959). These pigs were placed in an enclosure from which many escaped to the nearby mountains.

Three boars and nine sows from North Carolina were transplanted to the San Francisquito Ranch between Carmel Valley and Los Padres National Forest in Monterey County in late 1925 or early 1926. The original stock was supplemented in 1932 by 24 yearlings. The main movement of these pigs was south into the Santa Lucia Mountains.

Many domestic pigs were abandoned or escaped during the late 1800's and early 1900's and became established in the wilds of Monterey County. The European pigs bred with the feral pig populations and produced offspring with varying physical characteristics.

DESCRIPTION

The European wild pig and the domestic pig commonly interbreed. There is no problem discerning the difference between a typical barn-

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yard pig and a European wild pig, but the distinction becomes difficult after domestic pigs have bred in a feral state for several generations.

The most reliable method of identification is cytogenetic determination. The European wild pig has 36 (2N) chromosomes while the domestic pig has 38. The F_1 generation from a mating of the two is fertile and has 37 chromosomes (McFee, Banner and Rory, 1966).

Determination of type by field characteristics of size, color and conformation is not as exact as by cytogenetic determination. However, Stegeman (1939) lists a number of differences between the European wild pig and domestic pigs. European wild pigs are taller and heavier in the shoulder region; have a high and erect mane on the neck and along the spine above the shoulders; lighter and more angular hips; a long head with a slender snout; small, pointed and heavily haired ears; a tail which is long and mule-like; a thickened skin in males which forms a shield over the shoulders; heavier pelage bristles which are longer in the winter coat and supplemented by a dense undercoat of fine, curly, wool-like hair; a normal light to dark gray color (but this is not constant); longer legs; tracks which are farther apart and generally in a single line; and the young are striped longitudinally.

Some of the pigs in Monterey County exhibit these characteristics, but the long hair and fine undercoat are usually absent.

Pigs that are partially white or of mixed color are considered domestic or crosses. Solid dark colors indicate European, domestic, or crosses. However, most pigs in Monterey County exhibit partially white or mixed colors and varying body conformations indicating feral strains or mixed feral and European strains.

RANGE

The range of European wild pigs in Monterey County was determined by observing young striped pigs. Approximately 1,248 square miles in Monterey County are considered wild pig habitat (Figure 1).

The Carmel Valley pig population has expanded and moved southward since initial releases in 1925–26. In 1937, pigs were reported at the headwaters of the Arroyo Seco River (Von Blocker, 1937), 26 miles from the release site. Before 1952, William Randolph Hearst, Sr. reported pigs on his ranch near San Simeon. In the spring of 1957 wild trapped pigs were released at Nacimiento Summit by the Department of Fish and Game.

The range extension of the European strain has been difficult to authenticate because of the large number of feral pigs throughout the coast range. Often dark colored feral pigs are mistaken for European wild pigs by sportsmen and land-owners. Interbreeding between wild and domestic pigs create heterogeneous characteristics often resembling a "pure" wild, "pure" domestic or half-breed strains sometimes within the same litter (McFee, Banner and Rory, 1966). Range extension in the coast range also has resulted from unregulated pig liberations by land-owners or other individuals. This has been the general pattern of range extension of wild pigs throughout California.

MOVEMENT

Pigs are believed to be nomadic (Wodzicki, 1950), wandering in search of food and water. Once food is found, pigs usually stay until the supply is diminished or the animals are disturbed.

Trapping and kill data gathered from 1965 through September 1968, indicated less movement than expected. During this period 138 pigs were trapped, tagged and released; 53 were retrapped several times. One pig was retrapped 13 times.

The average distance traveled between retrapping was 0.2 mile. Only 10 of the 53 retrapped animals indicated any relatively large move-

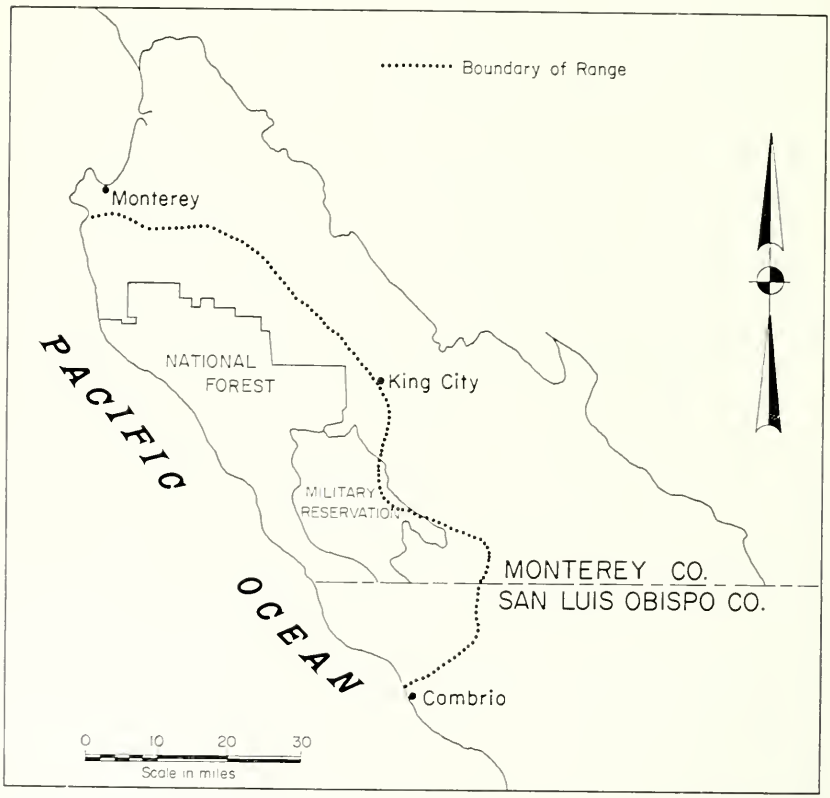

FIGURE 1. Estimated range of wild pigs in 1968. Range is the ocean side of the dotted line. The term "wild pig" here refers to European and feral domestic strains and their intergrades.

ment. They averaged 2.8 miles before retrapping. One adult male was recaptured 7 miles from the original trap site after 22 days and an adult female was recaptured 2.2 miles away after 1 day.

Tags from 29 hunter-killed pigs were returned. Hunter-killed pigs were taken an average of 2.6 miles from the trap site. Eleven males averaged 2.3 miles, while 16 females averaged 2.8 miles. One adult boar was killed at the trap site 145 days after release. Two young sows were

recaptured 6.8 miles from the trap site after 347 days. An adult sow was killed 3.5 miles from the release site after 582 days.

At Big Sur State Park and Carmel Valley in 1965–67, 25 depredating pigs were trapped, tagged and transported 14 to 25 airline miles into Los Padres National Forest. Tags were eventually received from eight of the animals. The greatest distance any of the pigs moved from the release site was 4 miles.

Pigs in Monterey County are influenced by available food and water. During the dry season pigs were usually found near or in damp creek bottoms. The animals apparently remain in an area as long as the food and water supplies last. However, if disturbed they will move to another area.

During winter and spring they are not dependent on permanent water. At this time wallows are often found along ridge tops on fire trails. There is rooting activity during this period in blue oak (*Quercus douglasii*) areas. As summer approaches the pigs move off the ridge tops and out of blue oak areas and return to the vicinity of available water and cover.

Changes in food supply influence pig populations. A large pig population existed for many years in the Arroyo Seco where barley was regularly planted. The rancher allowed the barley fields to revert to rangeland and within 3 years pig numbers had declined.

HABITAT AND WATER

Pigs in this area are generally found where coast live oak (*Quercus agrifolia*) is dominant. They are also in blue oak, but in smaller numbers. Pigs will use blue oak areas in the rainy season, but seldom during the dry summer.

Pig range in Monterey and San Luis Obispo counties coincides with average annual rainfall of 20 inches or more. Surface water and moist areas throughout the year are essential requirements. In particular, pigs are attracted to mud seeps or springs, and stream courses, preferably with a shaded vegetative overstory.

During the hunting season pigs are found usually in dense brush with a relatively open basal area. When hunted by dogs, the pigs seek large areas of dense escape cover. The common plants used for escape cover include: wild lilae (*Ceanothus* sp.), chamise (*Adenostoma fasciculatum*) and hollyleaf cherry (*Prunus ilicifolia*). In areas where light or no hunting pressure occurs little cover is needed.

Dense cover probably is needed for farrowing sites. One such site was located at the base of a cliff in a cave surrounded by chamise.

REPRODUCTION AND GROWTH

The peak breeding activity occurs from October through January. There is a 4-month gestation period. Evidence indicates pigs produce one litter a year. Pigs mature quickly. One sow, taken by a hunter, was 9.3 months old and showed evidence of farrowing. Therefore, she was bred at age 5.3 months. Two other sows, taken by hunters, were 7.6 months old and had fetuses about 1 month old.

The number of fetuses recorded for 12 sows killed at various times of the year ranged from one to nine with an average of five. Average

litter size, calculated from 32 field observations, was 4.2 with a range from one to eleven (Table 1).

Availability of food and water significantly affects reproduction and survival. In Tennessee, the years with greater mast crops produced a greater number of pregnant sows (Stegeman, 1939). Records at Hunter Liggett Military Reservation indicate a higher pig population can be expected after a good acorn production season (Table 2).

TABLE 1. **Reproduction Data 1964–1968**

Month collected	Sample size	Average litter size	Range per litter
January	5	5.5 (2)	5– 6
February	10	7.0 (3)	5–11
March	2	5.0 (1)	5
April	5	5.0 (5)	3– 7
May	5	3.0 (4)	2– 4
June	2	---- --	- -
July	7	4.2 (5)	1– 6
August	9	3.0 (1)	3
September	7	3.8 (4)	2– 5
October	9	2.8 (6)	1– 5
November	--	---- --	- -
December	1	4.0 (1)	4
Average		4.21 (32)	

( ) Number of litters sampled.

TABLE 2. **Pregnancy Rate in Relation to Previous Mast Crop**

Year	Number of reproductive tracts examined	Number pregnant	Estimate of previous fall mast crop
1965	7	6 (85.7)	Good
1966	4	3 (75.0)	Poor
1967	3	3 (100.0)	Excellent
1968	3	2 (66.6)	Poor

( ) Percent of sows pregnant.

Farrowing dates were determined by aging the hunter-killed pigs and then calculating time of birth. The aging method described by Matschke (1967) was used on all jaws collected in 1967 (Table 3). Pigs trapped before 1967 were aged by a method described in Farmer's Bulletin 721. This method was not as precise as Matschke's and was discontinued.

Some farrowing occurred during every month of the year. Most farrowing occurred from October through June with March the peak month. Little farrowing took place from July through September. Most pigs examined were born in the winter or spring.

The average growth rate for pigs trapped in 1966 was 0.20 lb. per day. In 1967 the rate was 0.11 lb. per day. The growth rates for 1966 and 1967 relate to the acorn production which was excellent in 1966 and poor in 1967 (Table 4).

There are weight differences within the various age groups. Some of the factors influencing weight differences include genetic factors and food availability.

TABLE 3. **Age Composition and Sex of Trapped Pigs, 1966–1967**

Age in months	Males	Females	Percent of total
0-1	- (--)	1 (--)	2 (--)
1-3	5 (1)	6 (--)	19 (2)
3-6	14 (19)	7 (24)	36 (66)
6-9	3 (5)	1 (7)	7 (18)
9-12	4 (1)	2 (--)	10 (2)
12-15	2 (--)	- (1)	3 (2)
15-18	2 (--)	1 (--)	5 (--)
18-20	1 (--)	- (--)	2 (--)
20-24	1 (--)	1 (2)	3 (3)
24 plus	5 (4)	3 (1)	13 (7)
Total	37 (30)	22 (35)	100 (100)

( ) 1967 sample.

TABLE 4. **Average Weight Gain in Pigs Trapped at Hunter Liggett Military Reservation 1966–1967**

Age in months	Sample size	Average weight in pounds first trapping	Average weight in pounds last trapping	Average weight in pounds added per day	Average number of days between trappings
1-3	4 (3)	31.0 (18.0)	41.0 (40.0)	0.25 (0.16)	40 (136)
3-6	6 (5)	37.5 (21.0)	80.5 (28.0)	0.18 (0.08)	240 (93)
6-9	-- (-)	---- (--)	---- (--)	---- (--)	-- (--)
9-12	2 (-)	100.0 (--)	104.5 (--)	0.13 (--)	34 (--)
12-15	1 (-)	50.0 (--)	63.0 (--)	0.26 (--)	40 (--)
Total	13 (8)	38.2 (24.8)	70.7 (31.2)	0.20 (0.11)	130 (105)

( ) 1967 data.

The largest pig live trapped weighed 335 lb. Another live trapped pig was estimated at 485 lb. The average hog dressed weight (without intestine, heart, liver and lungs) of 30 pigs taken from Hunter Liggett Military Reservation during the 1967–68 season was 82 lb. The largest was 205 lb. while the smallest was 14 lb.

MORTALITY AND SURVIVAL

Information on pig mortality and survival was collected during 1965, 1966 and 1967 trapping and tagging study and subsequent hunting seasons (Table 5).

TABLE 5. **Kill Records of Tagged Pigs 1965–1967**

	Year trapped and released			
	1965	1966	1967	Total
Number of pigs trapped, tagged and released	7	64	67	138
Number of tags returned	1	17	11	29
Percent of return	14.3	26.6	16.4	21.0

Pigs have been able to survive heavy hunting pressure. Annual hunting mortality of tagged pigs during the study ranged from 0 to 31%. Based on a Lincoln Index estimated pig population on Hunter Liggett Military Reservation, a mortality rate of 9% was calculated for 1966–67 and 19% for 1967–68.

During the 1967–68 hunting season 80% of the animals taken were less than 26 months old. This was expected because this age group accounted for 90% of the pigs trapped the previous summer.

Pigs under one year of age made up the bulk of animals in the population that were trapped or killed.

The sex ratio was 44% males and 56% females for animals taken during the 1967–68 hunting season (Table 6). The female kill was expected to be higher because of vulnerability. Hunter selection was probably the reason for a nearly equal kill ratio. A boar is normally chosen over a sow, especially if the sow has a litter.

No information was collected on natural predators of wild pigs.

TABLE 6. Age Composition and Sex Ratio of Pigs Killed on Hunter Liggett Military Reservation 1967–68 Season

Age in months	Male	Female	Percent of kill in age group
0–1	--	--	--
1–3	1	1	5
3–6	1	2	8
6–9	4	10	36
9–12	3	2	13
12–15	3	--	8
15–18	2	--	5
18–20	--	1	2
21–24	--	2	5
24 plus	3	4	18
Total	17	22	100

POPULATION DENSITY

Wild pig populations were calculated by the Lincoln Index method on Hunter-Liggett Military Reservation in 1967 and 1968.

Prior to the 1966–67 hunting season 48 pigs were trapped, tagged and released. At the end of the season 30 pigs were taken of which four were tagged. The calculated population at the end of the hunting season was 330. Pig density for the 250 square mile Hunter-Liggett Military Reservation was 1.3 per square mile. Applying this density to the entire Monterey County pig range results in a population estimate of 1,622.

Sixty-two pigs were trapped and marked on the same area in 1967. At the end of the 1967–68 season, 115 pigs were taken of which 11 were tagged. The calculated population for the military reservation was 533 or 2.1 pigs per square mile. These figures project for the county to 2,600. The population figures for the 2 years correlate with what might have been expected from the forage and water conditions for the two seasons.

Pig densities are low in Monterey County when compared with some areas of the southeastern states which have as high as 75-100 pigs per square mile (Hanson and Karstad, 1959).

HUNTING

Prior to 1956 there was no season or bag limit on wild pigs. In 1956 a 6-month hunting season was established for Monterey County with a one-pig per day bag limit. At that time, Monterey County was the only county in California known to have European wild pigs. The establishment of a season and bag limit directed attention to pigs as sporting animals and increased their popularity and status as game animals.

Pig hunting activity was investigated the opening week end of the 1966–67 season, and 103 hunters checked took only one pig. Of the hunters checked, 56 had no prior pig hunting experience. Opening of the pig season in late September is not necessarily the best time to hunt because the weather is normally warm and dry. Many hunters prefer to wait for the first good rains so the pigs can be located by fresh rootings and tracks. Hunting with dogs usually increases the success in finding pigs. However, the use of dogs for hunting on Hunter-Liggett Military Reservation was prohibited by the military after the 1962–63 season.

Pigs were trapped and marked in 1965, 1966 and 1967. Kill returns from these animals varied from 14.3% to 26.6% and averaged 21% over the 3 years (Table 5).

Eighty percent of the pigs taken during the 1967–68 hunting season were less than 26 months old. At Hunter-Liggett over 60% of the pigs taken the 1967–68 season were 12 months old or less (Table 6).

The general impression derived during the study is that wild pigs are able to maintain their numbers despite hunting.

DEPREDATION

Wild pigs have a reputation of causing trouble. Complaints have been received of pigs terrorizing campers, knocking over garbage cans, depredating artichoke and grain fields and ruining natural springs.

Control measures vary. Pig problems at Big Sur State Park were due to tameness of the animals. Nightly they knocked over garbage cans in search of food and posed a threat to the public. Control measures included trapping and removal of some of the animals, and use of pig-proof garbage containers. These actions virtually eliminated the problem.

The greatest problems occur in agricultural areas, particularly grain fields. The problem is not the amount they eat, but what they knock down or root up in the process of feeding and moving about. Normally, pigs invade crops at night and return to cover during the day. However, if left undisturbed they may spend the entire day in the fields. Their normal practice of returning to cover early in the day makes them difficult to control particularly where the cover is on a ranch adjacent to the one having the problem. The rancher who has daytime cover may not want them removed. Depredation can usually be controlled where hunting is allowed.

In Monterey County some depredation problems occur during the closed season. The only way pigs can be taken legally by landowners during this time is on a depredation permit. Past problems have not been very intensive if the number of pigs taken on depredation permits is any criteria. From 1959 to 1967 only an average of seven pigs were taken per year.

The effect of pig rooting on rangeland can be beneficial or detrimental. Rooting loosens and aerates the soil. Wild oats (*Avena fatua*) and filaree (*Erodium* sp.) often grow taller in areas where pigs have rooted.

FOOD HABITS

Stomach samples analyzed were from 89 wild pigs taken in Monterey, San Luis Obispo and San Benito counties during 1964–68 (Table 7). Analyses of samples were performed by the Department's food habits laboratory.

Wild pigs, like domestic pigs, apparently are quite omnivorous. Grass, forbs, some cultivated grain, acorn mast, berries, fruits, leaves, bulbs, roots, carrion, earthworms and insects, all were significant food items. Although the samples are relatively small and scattered over a period of 5 years and from 3 counties, the results indicate a seasonal pattern in the food habits for the central coast area.

In the spring the wild pigs apparently graze on grass and forbs. Green grass leafage and stems together with seeds, pods, leaves and stems of weedy annuals such as clover, bur clover and miner's lettuce, made up almost two-thirds of the spring diet. Over a third of the spring samples contained earthworms indicating rooting activity at this time.

A small summer sample contained acorns, grass, roots and bulbs; the latter two items indicate further rooting activity in the absence of green forbs. Summer months, when food is in short supply and rooting difficult, probably are critical for the foraging pigs.

Food conditions usually improve in the fall when mast (particularly acorns), berries, fruits and oak leafage become available. Mast, together with grass, bulbs and roots comprised 60% of the fall diet. Carrion, some of which was identified as deer, was found in several stomachs collected in the fall.

Mast, grass, bulbs and roots also comprised the bulk of the winter diet of the pigs sampled. In addition to the bulbs and roots, earthworms were found in a third of the winter stomachs.

DISCUSSION

The European wild pig was brought to Monterey County as a game animal. Cross breeding with feral domestic pigs has in many instances disguised the wild characteristics. However, hunting wild or feral pigs provides a popular and exciting sport for thousands of sportsmen each year. The sportsmen of Monterey County are concerned with the county's pig population to the extent that they secured county fine monies to study the wild pig.

For greater enhancement of the wild pig population, the season should be closed the first of March. A 5-month hunting season begin-

TABLE 7. **Food Eaten by 89 Wild Pigs, Monterey, San Luis Obispo and San Benito Counties, 1964–1968**

Vegetation	Winter* (34)		Spring (25)		Summer (7)		Fall (23)	
	V%	F	V%	F	V%	F	V%	F
Grass and grass-like plants								
Grass leaf and stems (Gramineae)	15.9	21	30.2	23	25.6	5	11.3	10
Wild oat seeds, *Avena fatua, A. barbata*	Trace	1	4.8	8	----	--	4.7	2
Spikerush seeds, *Heleocharis palustris*	----	--	----	--	3.6	3	----	--
Ryegrass seeds, *Lolium* sp.	----	--	Trace	3	0.6	3	Trace	4
Rip-gut seeds, *Bromus rigidus*	0.2	8	----	--	Trace	2	Trace	1
Grass subtotal	16.1		35 0		29.8		16.0	
Mast								
Oak acorns, *Quercus* sp.	16.3	9	6.8	3	34.3	3	16.0	8
California bay fruit, *Umbellularia californica*	1.2	3	8.6	6	----	--	4.0	8
Tanbark oak acorns, *Lithocarpus densiflorum*	8.7	12	----	--	----	--	----	--
Poison-oak fruits, *Rhus diversiloba*	----	--	----	--	----	--	6.1	6
Unidentified nuts, (*Lithocarpus, Yucca*)	5.4	6	0.2	1	----	--	0.2	4
Holly-leaf cherry fruit, *Prunus illicifolia*	----	--	----	--	----	--	5.1	4
Toyon berries, *Photinia arbutifolia*	----	--	3.6	1	----	--	Trace	1
Manzanita berries, *Arctostaphylos* sp.	----	--	----	--	0.7	1	----	--
Unidentified fruit (drupe)	----	--	----	--	----	--	0.4	2
Oak leafage, *Quercus* sp.	0.1	5	----	--	Trace	2	Trace	1
Mast subtotal	31.7		19.2		35.0		31.8	
Forbs								
Clover leafage, *Trifolium* sp.	0.9	6	15.9	8	Trace	1	Trace	2
Bur clover pods and leafage *Medicago hispida*	Trace	2	6.7	10	Trace	1	5.2	6
Unidentified forbs leafage, stems	3.4	19	2.9	20	Trace	4	Trace	4
Miner's lettuce seeds and leafage, *Montia perfoliata*	----	--	4.0	4	Trace	1	----	--
Filaree leafage, seeds, *Erodium* sp.	1.5	6	Trace	4	Trace	1	----	--
Fungi (Mushroom)	----	--	----	--	----	--	0.7	1
Thistle seeds, leafage, *Cirsium* sp.	Trace	1	Trace	2	----	--	0.2	2
Forb subtotal	5.8		29.5		Trace		6.1	
Bulbs, roots, fungi								
Lily corms, bulbs, leafage (Liliaceae)	6.0	8	0.4	4	14.4	2	7.6	5
Brodiaea (corms), *Brodiaea* sp.	Trace	1	----	--	13.6	1	Trace	1
Unidentified roots, (root stalk)	7.0	4	3.8	4	----	--	4.3	5
Underground vegetative subtotal	13.0		4.2		28.0		11.9	

TABLE 7. **Food Eaten by 89 Wild Pigs, Monterey, San Luis Obispo and San Benito Counties, 1964–1968—Continued**

Vegetation	Winter* (34)		Spring (25)		Summer (7)		Fall (23)	
	V%	F	V%	F	V%	F	V%	F
Cultivated foods (mostly bait)								
Barley (grain), *Hordeum vulgare*	19.3	8	5.9	6	----	--	14.8	5
Vegetative fragments	----	--	0.4	1	----	--	0.3	2
Cultivated subtotal	19.3		6.3		----		15.1	
Animal foods (mostly carrion)								
Unidentified animal (flesh, organs)	3.6	2	----	--	----	--	11.1	6
Deer (hair, flesh) *Odocoileus hemionus*	4.9	3	0.2	1	----	--	5.1	4
Earthworm fragments, *Annelida* sp.	4.0	11	5.3	9	Trace	2	0.7	5
Ground squirrel (tail, foot), *Citellus beecheyi*	----	--	----	--	7.1	1	----	--
Unidentified mouse (tail, bone, flesh) (Rodentia)	----	--	----	--	----	--	2.2	5
Gopher (hair, flesh, bones), *Thomomys bottae*	1.6	1	Trace	1	----	--	----	--
Insect larvae	Trace	4	0.1	5	0.1	1	Trace	1
Insect (Adult) (Insecta)	Trace	9	0.2	5	Trace	3	Trace	3
Animal subtotal	14.1		5.8		7.2		19.1	

* Winter: December–February.
Spring: March–May.
Summer: June–August.
Fall: September–November.

ning in October would give the pigs an opportunity to gain weight and disperse themselves during years with good acorn production or early rains. Pigs born in March should be huntable size by October. Restricting the use of dogs for pig hunting could be used as a management tool in marginal or reduced animal population areas.

A technique is needed to provide an index to population and/or kill trends in order to evaluate population changes. Use of check stations is not feasible where long hunting seasons are in effect and where use and kill values fluctuate significantly. The traditional tag system may not measure yearly trends where hunter tag returns are poor or where use in one county is being measured. A tag system limited to one area or county would not be feasible. However a tag system covering the entire State would yield biological and hunting data for management of this game mammal. Other recommendations based on this study are as follows:

1) In areas where pigs are abundant, populations should be managed.

2) Hunting should be encouraged in areas of agricultural damage. Continue present policy of issuing depredation permits during the closed season.

3) Restrictions on dog use may be needed in areas where pig populations are low or declining.

4) Maintain present hunting season in Monterey County. If additional season restrictions are necessary the season should be closed on the last day of February.

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NOTES

RESULTS OF THE 1971 PISMO CLAM CENSUS

Pismo clam censuses have been taken by the Department of Fish and Game since 1923 at three locations on Pismo Beach and since 1949 at Morro Bay. Censuses prior to 1971 were reported by Carlisle (1966), Baxter (1961, 1962) and Fitch (1950, 1952, 1954, 1955), Collyer (1951), Aplin (1947).

Full-scale annual Pismo clam censuses are no longer conducted. Instead, spot checks are made each winter to determine the extent of recruitment during the previous spawning season. The present plan calls for full-scale censuses at about 5-year intervals. The last full census was conducted in 1965 and the results were published for the period 1961–1965 (Carlisle 1966).

Due to a postponement, the 1971 census was actually conducted in January 1972, Table 1.

Data are presented here from spot checks and the only full-scale Pismo clam census conducted by the California Department of Fish and Game since 1965. No strong recruitment has occurred since the years 1964 and 1965, and survival of clams from these 2 years at Pismo Beach has been poor. Although there was some recruitment at Morro Bay in 1966 and 1967, the first in 20 years, survival here too has been poor.

TABLE 1. **Number of Clams Taken in 1971 Census by Year-Class**

Year-class	Le Grande section	Oceano section	Pismo section
1962	0	0	0
1963	0	0	0
1964	0	0	0
1965	1	1	1
1966	3	3	2
1967	4	2	2
1968	6	5	2
1969	3	2	0
1970	11	8	14
1971	0	0	0
Totals	28	21	21

In general, there has been only poor to fair recruitment in the years since 1965. In 1966 and 1967 the sets were fair; very few zero year class clams were formed in 1968; a very poor set occurred in 1969, and in 1970 recruitment was somewhat better, but still not good.

As has been the situation for many years, clamdiggers find it necessary to probe in waist-deep water during the better minus (below 1-ft) tides of the year to obtain a limit of clams. In general, really good digging is found only on an exceptional sand bar. Otherwise, obtaining a limit of 10 clams is an arduous task.

LE GRANDE SECTION

This section, normally the least productive of the three Pismo Beach locations, is about 5 miles south of the Pismo Beach pier.

The only set that can be considered fair occurred here in 1970, 11 of this year-class were taken; the other year-classes must be considered very poor. This compares with a take of 40 zero year-class clams in 1965, the last full census year.

OCEANO SECTION

The Oceano Section was closed to digging from 1949 until 1955.

As at the Le Grande Section, the sets were poor. Only 1970 can be considered even fair. The eight 1970 year-class clams dug in 1971 compares to 75 zeros dug in 1965.

PISMO SECTION

This section, just north of the Pismo Beach pier, has never been closed to digging. The 1970 set appears to have been a little better than that at the other two locations; 14 clams of that year-class were dug during the 1971 census. No zeros were found. The other years produced very few zero year-classes. This is poor when compared with 1965 where 126 clams of the year were dug.

MORRO SECTION

No clams of any size were dug in the Morro Beach section during the 1971 census. It now appears that survival of the 1966 and 1967 year-classes, which offered some encouragement, has been poor. There is no evidence to indicate that the serious situation at Morro Bay has been in any way relieved.

DISCUSSION

The last good recruitment occurred at Pismo Beach in the years 1964 and 1965. Unhappily, the 1971 census did not produce any evidence that there has been good survival of these two year-classes. Until good recruitment and survival does occur, it would be unrealistic to assume an optimistic attitude toward the future of clam digging at Pismo Beach. The situation looks even worse at Morro Bay.

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RECORDS OF THE CALIFORNIA TONGUEFISH, THREADFIN SHAD AND SMOOTH ALLIGATORFISH FROM YAQUINA BAY, OREGON

A systematic program of beam trawling in Yaquina Bay, Oregon (lat 44° 36′ N), part of the Oregon State University Sea Grant Program, has resulted in the capture of three species of fish well outside of their normal ranges. These are the California tonguefish, *Symphurus atricauda* (Jordan and Gilbert). the threadfin shad, *Dorosoma petenense* (Günther) and the smooth alligatorfish, *Anoplagonus inermis* (Günther) (Table 1).

The California tonguefish is normally found south of Monterey Bay, California (Roedel, 1953). The previous most northerly record for the species was Big Lagoon, Humboldt County, California (Miller, Gotshall and Nitsos, 1965). The presence of a few members of an apparently single year class in Yaquina Bay, 240 miles north of Big Lagoon, may be due to successful drift of larvae in the northerly directed Davidson Current. The current travels northward from October through February going from Point Conception to northern Washington (Reid and Schwartzlose, 1962).

Temperature and salinity relationships of the threadfin shad were discussed by Bryan and Sopher (1969) who considered the possibilities of the species becoming established in Humboldt Bay, California. Suitable salinities for threadfin shad spawning exist in the upper sections of Yaquina Bay, 268 miles north of Humboldt Bay, and the salinity preferendum for adults and young may also be found within the Yaquina Bay system (Miller, 1963). Parson and Kimsey (1954) stated that spawning temperatures for the threadfin shad was not known but that approximately 21 C was suitable. Rawstron (1964) observed spawning in Pine Flat Lake, California when surface temperatures were 14.4 and 16.8 C. These temperatures are within the temperature range experienced in Yaquina Bay. The likelihood of this species becoming established within the bay seems more dependent upon the minimum temperatures during the year than the availability of suitable spawning temperatures. In Yaquina Bay, the temperature may fall to 6.5 on the bottom and to 5 C on the surface. Parsons and Kimsey (1954) reported high mortality for threadfin shad below 7.2 and almost no survival at 4.4 C in fresh water. Due to the low temperatures experienced within the bay, it is doubtful that the threadfin shad can become established in Yaquina Bay.

Although the probability of natural migration of threadfin shad to Yaquina Bay seems small when the distance and the temperature and salinity gradients to be traversed are considered, the threadfin shad is not known to have been introduced legally or illegally to Oregon (Reino Koski, Oregon State Game Commission, pers. comm.).

The smooth alligatorfish has been reported in Oregon only in the Columbia River (Eigenmann and Eigenmann, 1892). The range given by Clemens and Wilby (1961) is from Washington to the Gulf of Alaska. The regular occurrence of this species in Yaquina Bay is a 120-mile southerly extension of their known range. We assume that under intensive sampling the smooth alligatorfish would be found in Oregon waters north of Yaquina Bay.

TABLE 1. **Data on the California Tonguefish, Threadfin Shad and Smooth Alligatorfish from Yaquina Bay, Oregon**

	OS catalog	Length (mm)	Date collected	Depth of capture (meters)	Distance from ocean (miles)	Surface temperature C	Bottom temperature C	Bottom salinity °/₀₀	Location
Symphurus atricauda	3618	25	4/24/70	9	2.5	10.0	9.8	32.8	Sallys Bend
S. atricauda	3712	71	3/15/71	9	2.5	9.0	8.2	28.6	Sallys Bend
S. atricauda	3713	70	3/29/71	8	4.0	9.5	9.0	19.4	River Bend
S. atricauda	3624	62	6/06/71	9	4.0	12.8	12.6	29.5	River Bend
Dorosoma petenense	3619	99	1/27/70	10	4.0	9.0	8.3	4.6	River Bend
Anoplagonus inermis	3710	110	1/18/71	14	.7	9.5	9.0	27.6	Newport Bridge
A. inermis	3711	79	3/01/71	12	.7	6.5	7.8	32.1	Newport Bridge
A. inermis	3718	82	8/13/71	13	.7	7.8	10.7	33.8	Newport Bridge
A. inermis	4009	64	2/11/72	14	.7	8.2	8.1	31.5	Newport Bridge

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FIRST RECORD OF THE SMOOTH ALLIGATORFISH, *ANOPLAGONUS INERMIS* (FAMILY AGONIDAE), FROM CALIFORNIA WATERS

On August 15, 1972, while collecting subtidal fishes using Chem Fish Collector (a rotenone-base ichthyocide) and SCUBA, a specimen of the smooth alligatorfish, *Anoplagonus inermis* (Günther, 1860) was procured at Arena Cove (lat 38° 54′ 56″ N, long 123° 43′ 26″ W). The specimen, 38.1 mm SL (43.4 mm TL), was taken in 30 ft of water over a rubble bottom interspersed with small patches of sand. The fish itself came from a sandy area.

The original description was based on a single specimen collected off Vancouver Island, British Columbia, the species placed in the genus *Aspidophoroides* Lacépède. A year later, Gill (1861) established the genus *Anoplagonus* and designated *A. inermis* the type-species, stating "This genus is allied to *Aspidophoroides*, but is readily distinguished by the presence of vomerine and palatine teeth." Jordan and Evermann (1898, p. 2093) give an excellent description of this agonid under the genus *Aspidophoroides* Lacépède (subgenus—*Anoplagonus* Gill). In Jordan's (1923) "A classification of fishes . . ." the genus *Anoplagonus* was again recognized, however, it was placed in a new family Aspidophoroididae with three other "agonid" genera. Jordan, Evermann, and Clark (1930) basically followed Jordan's earlier classification, continuing to recognize the family Aspidophoroididae. Berg (1940) united Aspidophoroididae with Agonidae, the view currently in acceptance.

The range of this species has been given as follows: (Jordan and Evermann, 1898) "Coast of Alaska, south to Vancouver Island; not

abundant . . ."; (Schultz, 1936) "Alaska to Columbia River Mouth. Marine. Common."; (Wilimovsky, 1958) "Gulf of Alaska—British Columbia; Korea." Clemens and Wilby (1961) give a description, illustration, known size and range of "Washington to Gulf of Alaska" and also state, "The species usually is taken by shrimp trawlers near and on rocky bottoms at depths between 15 and 30 fathoms." Most recently Krygier, Johnson, and Bond (1973) report this fish from Yaquina Bay, Oregon. The Arena Cove specimen represents the first record of *Anoplagonus inermis* off California and a southward extension of the range of over 360 miles. The smooth alligatorfish brings to 18 the number of known agonids from California waters (Fitch, 1966; Miller and Lea, 1972).

Meristics and morphometrics for the California specimen are given in Table 1.

TABLE 1. **Meristics and Morphometrics on California Specimen of *Anoplagonus inermis***

Measurements	mm	Percent of SL
Standard length	38.1	----
Total length	43.4	113.9
Head length	9.0	23.6
Orbit diameter	1.8	4.7
Interorbital width	1.6	4.2
Snout length	2.5	6.6
Body depth at dorsal origin	1.8	4.7
Pectoral length	6.5	17.1
Pelvic length	3.7	9.7
Predorsal length	22.2	58.3
Preanal length	21.9	57.5

Counts	
Dorsal fin	6
Anal fin	5
Pectoral fin	10-10
Pelvic fin	I,2
Caudal fin (principal rays)	11
Branchiostegals	6
Lateral line pores	43
Plates (terminology following Gruchy, 1969).	
Total dorsal	42
Dorsolateral	28
Mid-dorsal (=postdorsal)	14
Predorsal	21
Total ventral	41
Ventrolateral	26
Midventral (=postanal)	15
Preanal (from pectoral base)	19
Supralateral	41
Infralateral	40

The smooth alligatorfish can be distinguished from all other California members of the family Agonidae by the absence of the spinous dorsal fin (only one dorsal fin is present as opposed to two, the normal agonid condition). Other diagnostic characters are dark body coloration (blackish in the Arena Cove specimen); two whitish patches on caudal fin, one dorsally and one ventrally; a white band near the base of the pectoral fin; and plates on body smooth, without spines.

This specimen is deposited in the Department of Ichthyology, California Academy of Sciences; catalog number CAS 15049.

I would like to thank Department colleagues Daniel W. Gotshall, Laurence L. Laurent and Jay Baumler for aiding in the collection of this and other fishes from Arena Cove.

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POTENTIAL DANGER FROM THE INDIAN CATFISH, *HETEROPNEUSTES FOSSILIS* (BLOCH)

Fisheries workers and others handling fishes should be aware of the potential danger from the sting of the freshwater catfish, *Heteropneustes fossilis* (Figure 1). *H. fossilis,* native to India, Ceylon, Burma, and Cochin China, has recently been imported illegally into California for the tropical fish trade. It is a member of the family Clariidae and is one of four genera prohibited in California (Sections 671–671.7, Title 14, Calif. Admin. Code and Fisk 1969).

In 1971, a Pomona tropical fish importer contacted the junior author to identify a shipment of 200 exotic catfish. The fish were identified as *H. fossilis.* Confirmation of the identification was made by Jon Baskin, California Polytechnic University, Pomona. An additional 300 specimens were confiscated from a Long Beach importer.

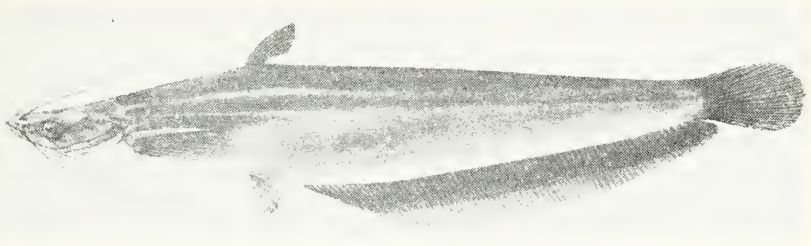

FIGURE 1. Indian catfish. Photo from Halstead, 1970.

H. fossilis has well developed venom glands associated with the pectoral spines and can introduce venom into wounds produced by these spines (Bhimachar 1944; Fernando 1964; Fernando and Fernando 1960). The tip of the pectoral spine is sharp and the shaft has sharp, recurved denticles which can produce both penetrating and cutting wounds.

Wounds are characterized by severe pain and inflammation, often lasting several hours. Fainting, and temporary paralysis of the affected limb have also been noted. Secondary bacterial infections, which delay healing, and anklysosis, or fusion, of the joints of the fingers near the site of the wound have been reported by Fernando and Fernando (1964). Bhimachar (1944) believes the venom has both hemolytic and neurotoxic properties. A crudely prepared extract of dried *H. fossilis* spines killed frogs within a few minutes after injection and the same extract caused a breakdown of mammalian red blood cells.

While no human deaths have been reported by reliable observers, a sting from *H. fossilis* is painful and potentially dangerous. Halstead (1970) stresses the aggressive behavior of this fish, which has resulted in distinct attacks on humans and other fishes. Great care should be taken when handling live or unpreserved specimens that have recently died. *H. fossilis* is extremely supple and can bend backward upon itself very rapidly, stinging the unwary handler; when held with forceps near the tail, the fish can turn backward so far that it stings itself. They should not be touched with the bare hands and should always be treated with caution because of their reputed aggressive behavior and venomous properties.

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PARTIAL AMBICOLORATION IN THREE CALIFORNIA FLATFISHES

During the past year Yucci caught three species of partially ambicolorate flatfishes from the Santa Barbara Channel near Santa Barbara, California: longfin sanddab (*Citharichthys xanthostigma*), fantail sole (*Xystreurys liolepis*), and c-o sole (*Pleuronichthys coenosus*). Dawson (1962) and Eisler (1963) do not list these three species in their recent summaries of such abnormal occurrences among flatfishes. The live fantail and c-o soles were observed for several weeks.

Longfin sanddab (Figure 1)—The fish was caught in November 1971 by otter trawl in 40 ft of water just seaward of a kelp bed located about 1 mile east of Santa Barbara harbor. It was 127 mm SL and the right or lower surface was about two-thirds pigmented. The unpigmented region included the head and about one-fifth of the adjacent body. Pigmentation of colored areas appeared no different between eyed and blind side. No other abnormalities were detectable from radiographs or further external examination. Eisler (1963) noted that partially ambicolorate flatfishes seldom display abnormalities of eyes, fins or scales. This held true for all three specimens reported in this note.

C-O Sole (Figure 2)—This fish was caught in April 1972 at a depth of 50 ft about ½ mile south of Santa Barbara Pt. It was 186 mm SL and the blind left side was about four-fifths colored. The unpigmented region included the head, a very small region adjacent and dorsal to the operculum and a small patch in the pectoral axilla. As in the longfin sanddab, no further external and internal abnormalities were found.

Fantail sole (Figure 3)—In June 1971 a partially ambicolorate fantail sole was caught on hook and line in 15 ft of water near the Santa Barbara pier. It was 195 mm SL. About two-thirds of the blind side was darkly pigmented. Lighter areas included the head and a dorsal strip extending from the head to about the 35th dorsal ray. In the fantail sole a strip of light yellow in the dorsal strip adjacent to

FIGURE 1. Blind side of longfin sanddab. *Photograph by Milton Love, July 1972.*

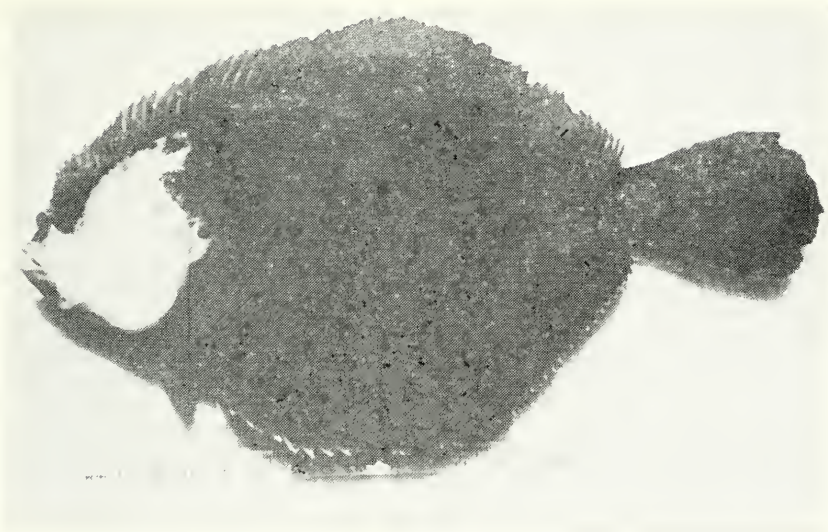

FIGURE 2. Blind side of c-o sole. *Photograph by Milton Love, May 1972.*

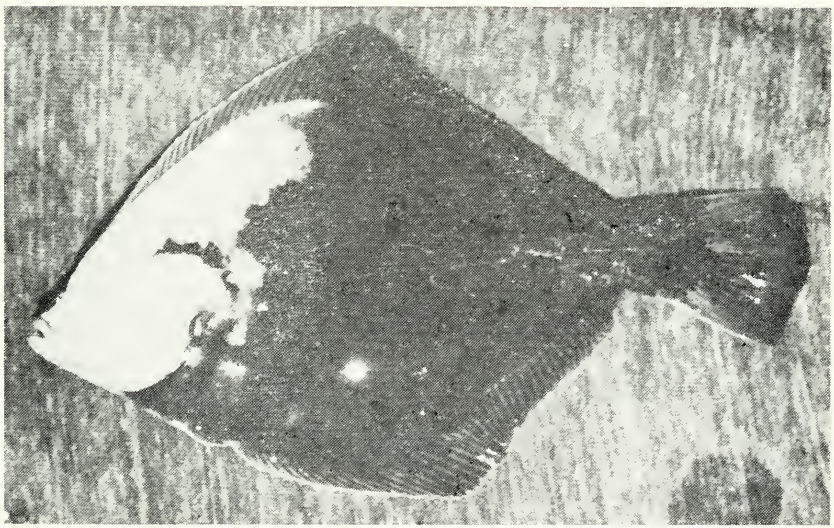

FIGURE 3. Blind side of fantail sole. *Photograph by Eldon Ball, July 1971.*

the dark brown pigment gave way to white on the head. No other external abnormalities were found.

Both the fantail and c-o soles were kept live in 54 x 42 x 7 inch plywood tanks for several weeks during which we observed their swimming and feeding behavior. The fishes were fed chopped rock scallops and anchovies. Their swimming and feeding behavior resembled that of normally colored individuals.

We observed coloration and color changes of the fishes in a 24 x 18 x 6 inch plexiglas bottomed tank, which was elevated to expose the fishes' blind sides. Dawson (1962) noted that the coloration and markings of an ambicolorate *Paralichthys lethostigma* on the eyed and blind sides were similar. This was also noted in the fantail and c-o soles.

Color changes were elicited by prodding the fish with a glass rod. This caused extensive changes in markings and in coloration. The c-o sole tended to form large, somewhat irregular dark blotches, while the fantail sole usually became darker and acquired many small bluish dots. In the ambicolored c-o sole, the blotches on the eyed side were quite closely matched in size, shape and position with the blotches on the blind side. On the fantail sole there appeared to be about equal numbers of spots per unit area on each side. The time taken to begin color or pattern changes was about the same for both sides. Similarly, there was no apparent difference in the time taken to complete these changes.

The authors wish to thank A. W. Ebeling, University of California, Santa Barbara, for reviewing this note.

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—*Milton S. Love, Department of Biology, University of California, Santa Barbara and John Vucci, Santa Barbara Underseas Foundation, Santa Barbara, California 93017.* *Accepted for publication December 1972.*

A DEFORMED KELP BASS, *PARALABRAX CLATHRATUS* (GIRARD), FROM ALIJOS ROCKS, BAJA CALIFORNIA

On 8 November 1970 a snubnosed kelp bass with maxillary and premaxillary abnormalities was captured at Alijos Rocks, Baja California, aboard the sportfishing boat *H & M 85*. This is the second anomalous individual recorded for this species. The only other abnormal kelp bass reported was a single specimen with elongated dorsal, anal, caudal and ventral fin rays caught off San Clemente Island, California, in June, 1953 (Baxter, 1954).

X-ray (Figure 1) and external examination (Figure 2) indicate that this specimen has the following abnormalities: (i) premaxillaries present, but reduced in size, (ii) left maxillary absent, right maxillary present but projecting forward, (iii) snout shortened, vomer reduced and (iv) a large calcified knob on the right ceretohyal. No other deformities are present using the criterion applied to sand bass (*P. nebulifer*) by Valentine and Bridges (1969). Other statistics are given in Table 1. Counts generally fall within the range given by Baxter (1954) for kelp bass from Southern California.

It is also of interest to ask whether deformities of the type described are developmental (appearing with age) or congenital (present from

TABLE 1. **Statistical Data from Deformed Kelp Bass Specimen**

Bilateral structures	Counts	
	Right side	Left side
Gill rakers, upper limb	13	13
Gill raker at angle	1	1
Gill rakers, lower limb	24	23
Pectoral fin rays	14	14
Ventral fins	I,5	I,5
Pored lateral line scales (to end of hypural plate)	67	68

Midline characters	
Dorsal fin	X,13
Anal fin	III,7
Other statistical parameters	
Weight	1,050 g
Standard length	363 mm
Total length	443 mm
Sex	undeterminable

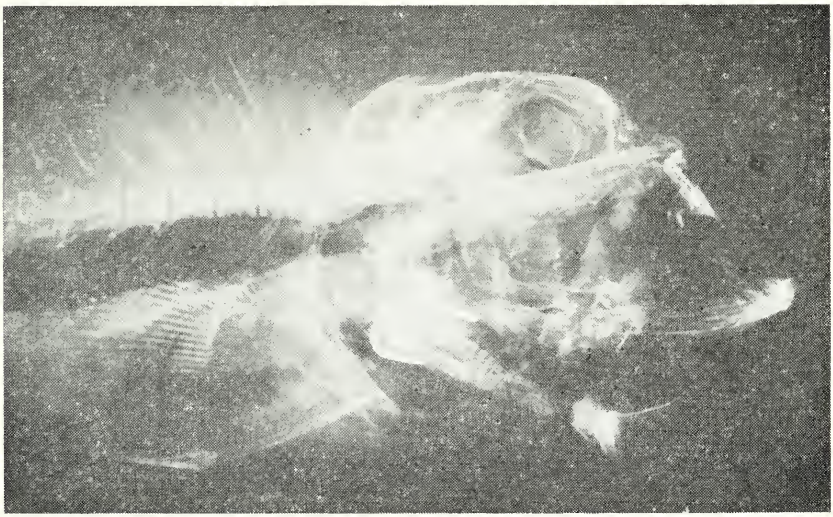

FIGURE 1. X-ray of deformed kelp bass (*Paralabrax clathratus*). Hook shown is that on which this specimen was captured.

"birth"). A definitive answer is, of course, impossible. Developmental deformities are necessarily limited to existing structures. The complete lack of the left maxillary strongly suggests that these deformities are congenital.

This specimen is also worthy of note because of the area from which it came. Alijos Rocks (lat 24° 57.7′N, long 115° 48.4′W) are situated almost 188 nautical miles due west of Cabo San Lázaro (near the mouth of Magdalena Bay and the southern limit of this species range) and 157 nautical miles southwest of Punta Abreojos, the closest point of

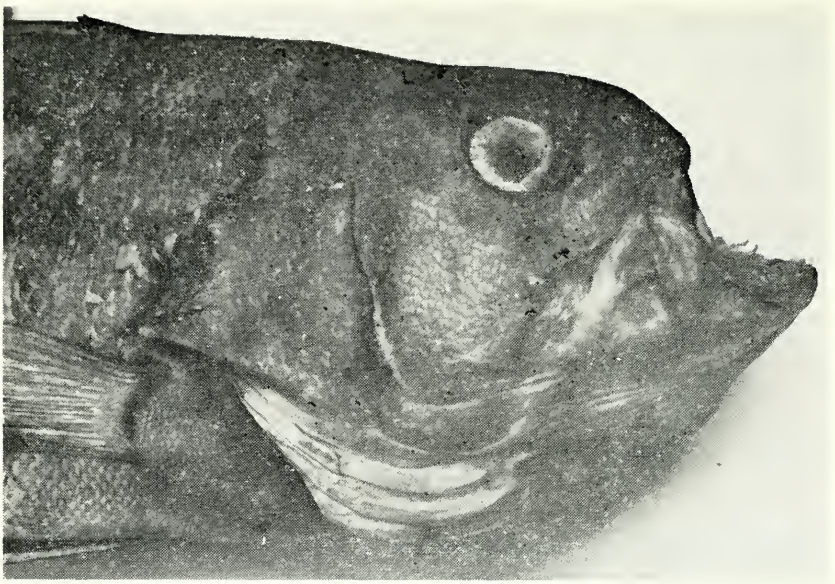

FIGURE 2. Photograph of deformed kelp bass (*Paralabrax clathratus*).

land. This specimen, then, represents one of the southernmost reported and the most distant from the mainland ever recorded.

Another adult kelp bass (351 mm SL) was captured at lat 25° 43'N, long 113° 09'W in 13 fathoms of water on February 19, 1970, again aboard the *H & M 85*. The closest mainland point in this instance is 42 nautical miles. Discussions with Bobby Wyer, captain of the *H & M 85*, who has spent the last 19 years piloting sportfishing vessels below Cedros Island, stated that large kelp bass are infrequently taken from many of the rocky banks in Baja California, including Alijos Rocks. Kelp bass, therefore, appear infrequent visitors to or rare residents of many of the offshore shallow rocky areas between Cedros Island and Magdalena Bay. Whether kelp bass breed in these areas or are simply expatriots from the mainland population is not known.

The deformed specimen is deposited in the ichthyological collection, Scripps Institution of Oceanography, accession number S1071-153.

Finally, we would like to thank Ralph Miller, Jr., of H & M Landing in San Diego for allowing collection of specimens from his sportfishing boats. We are also indebted to Bobby Wyer, captain of the sportfishing boat, *H & M 85*, for giving assistance and information during collecting trips aboard his ship in Baja California waters. And, to Robert Wisner, we would like to express our gratitude for the X-ray used in this communication.

This work was partially supported by grants from the Marine Life Research Group, Scripps Institution of Oceanography (No. 1273) and the Southern California Coastal Water Research Project (No. 02304).

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—*David W. Valentine, 1100 Glendon Ave., Los Angeles, California 90024 and Paul B. Samollow, Zoology Department, Oregon State University, Corvallis, Oregon 97331.* *Accepted for publication September 1972.*

AFRICAN CLAWED FROG, *XENOPUS LAEVIS LAEVIS* (DAUDIN), ESTABLISHED IN CALIFORNIA

Xenopus laevis laevis is a highly aquatic, tongueless frog of the family Pipidae which ranges throughout much of southern Africa. These smooth-skinned, brownish frogs are characterized by a flattened body and head, slender fingers, and large, fully webbed hind feet (Figure 1). The three innermost toes of each hind foot are capped with hard cornified structures loosely referred to as "claws". Adult females may reach 5 inches (snout-vent length). The tadpoles are catfish-like in appearance, having a flat head with two tenacles and a slender body and tail (Figure 2).

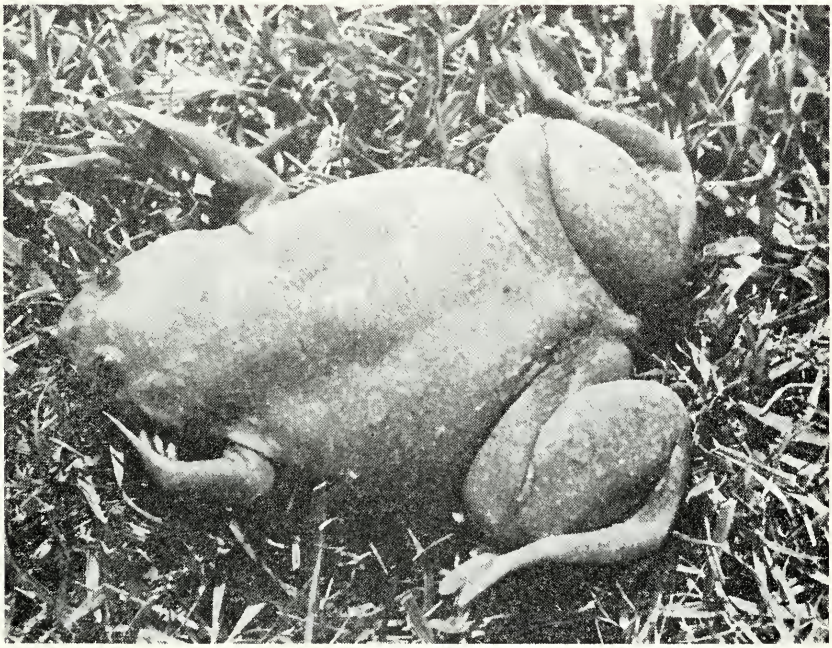

FIGURE 1. Adult female African clawed frog, collected April 6, 1971 at Mile Square Park, Orange County, California.

FIGURE 2. Tadpole of African clawed frog. Photo by Ward Gillilan.

African clawed frogs have been imported into the United States for medical and experimental use for several decades. More recently, they have been important items in the pet trade. We believe the specimens we collected originated from tropical fish importers in the Westminster area. Two tropical fish hatcheries imported the frog in the early 1960's for the wholesale trade. Joe Akiyama, owner of the Pacific Goldfish Farm, has observed *X. l. laevis* in his outdoor ponds although he has never imported them.

On May 1, 1968 three adult African clawed frogs were collected in the Ocean View Flood Control Channel, near Westminster, Orange County (St. Amant and Hoover 1969). Verification that this frog had become established was made when the senior author collected four tadpoles and observed adult clawed frogs in the East Garden Grove-Winterburg Channel, Orange County on July 17, 1970. The frog has also been reported from Slater Lake which is approximately ½ mile south of the channel.

Mike Curran, Supervising Park Ranger at Milesquare Regional Park in Fountain Valley, reported the clawed frog was abundant in the Park's 3-acre lake and the Ocean View channel which flows through the Park. During a survey of the waters in this area on April 6, 1971, Hoover and St. Amant collected 39 frogs, both adult and juveniles, with dip nets in the Ocean View channel. We also found thousands of clawed frog tadpoles in the East Garden Grove-Winterburg Flood Control Channel north of Milesquare Park and also where this channel joins the Ocean View channel 6 miles west of the Park. On May 10, 1971, the authors collected both adult and juvenile clawed frogs and numerous tadpoles in this same area. These collection sites are on the northwest side of the Santa Ana River. On July 18, 1972, we collected about 40 clawed frogs in the Greenfield-Banning Channel, which is on the southeastern side of the river and, like the other flood control channels, has no connection to the river.

Preserved specimens are now located in the collections at California State Polytechnic University, Pomona, and the Department of Fish and Game's Chino Fish and Wildlife Base, Chino.

X. l. laevis may also be established in other areas of southern California. Mahrdt and Knefler (1972) describe the discovery in 1971 of the clawed frogs in Sweetwater Reservoir, San Diego County. Arden Brame, Supervisor of the Eaton Canyon Nature Center, has a specimen that was collected from Muntz Lake near Palmdale, Los Angeles County.

The African clawed frog, which reproduces prolifically, could be detrimental to native amphibians and fishes because of its voracious, nonspecific feeding habits. An investigation of its potential impact is being conductd by a graduate student at California State Polytechnic University, Pomona. The Fish and Game Commission, acting on a recommendation by the Committee on Prohibited and Protected Fishes, Amphibians, and Reptiles of the Colorado River Wildlife Council, has prohibited importation and/or possession of the clawed frog in California, (Sections 671–671.7, Title 14 California Administrative Code). Arizona, Nevada, and Utah also prohibit this species.

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St. Amant, James A. and Franklin G. Hoover. 1969. Addition of *Misgurnus anguillicaudatus* (Cantor) to the California fauna. Calif. Fish Game 55(4) : 330–331.

——— *James A. St. Amant, Franklin G. Hoover, Inland Fisheries Branch, California Department of Fish and Game, Long Beach, Calif. 90802 and Glenn R. Stewart, Calif. State Polytechnic Univ., Pomona, Calif.* *Accepted June 1972.*

BOOK REVIEWS

The Biology of Lampreys (Two Volumes)

Edited by M. W. Hardisty and I. C. Potter; Academic Press, London-New York, Illustrated; Volume 1, 1971, xiv + 423 p. $23.50. Volume 2, 1972, xiv + 466 p. $18.50.

Hardisty and Potter have produced a fine monograph on the biology of lampreys. They have organized and synthesized a wealth of information which previously was scattered in the literature. The compilation will provide a valuable service to the student and professional biologist whose interests range from developmental biology and evolution to lamprey predation in the Great Lakes.

The editors were directly involved in the preparation of six of the 22 chapters, whereas other specialists were responsible for the remainder. The result is an impressive array of experts on various phases of lamprey biology. One of the dangers of this approach is the possibility of unequal treatment of the different topics. Much to their credit, Hardisty and Potter seem to have avoided this pitfall.

Considerable devotion to detail and quality has enhanced the value of these volumes as works of reference. Each chapter has a table of contents plus an extensive set of references, and each volume has a separate subject and author index. The illustrations are numerous and excellent.

Books of this type are expensive and these are no exception. Fishery biologists who can afford only one volume would do best to obtain Volume 1 since it contains chapters of more immediate interest; e.g., "Distribution, Phylogeny and Taxonomy", "The Behavior, Ecology and Growth of Larval Lampreys", "The General Biology of Adult Lampreys" and "Sea Lampreys in the Great Lakes of North America".—*Almo J. Cordone*

Fishing the Dry Fly as a Living Insect

By Leonard M. Wright, Jr.; E. P. Dutton and Co., Inc., N.Y., 1972. 187 p., illustrated. $6.95.

Mr. Wright fishes waters in the eastern U.S. and fishes the caddis hatches, which are frequently extremely abundant. His method, which he feels is unorthodox, is to cast a caddis dry fly imitation across and slightly downstream. When the fly lands, the line is twitched to move the fly, much as a living caddis might move when attempting to fly. He believes his method will move fish more effectively than the nymphs. He may be right; I intend to give his technique a try in the coming trout season. Illustrated directions are given for tying his "Fluttering Caddis" patterns.—*K. A. Hashagen, Jr.*

Trout Fishing

By Joe Brooks; Harper and Row, N.Y., 1972; XVI + 302 p. illustrated. $8.95.

Joe Brooks has written another fine fishing book, this one entitled "Trout Fishing". It is a book directed to fly fishermen, and has the usual chapters on the history of trout (fly) fishing, tackle and techniques, how to fish the dry, wet, nymph, and bucktails and streamers. There are also chapters on "How to Play a Trout" and "How to Wade a Trout Stream" and "Trout Flies".

I found little information in the book that was new or different from the existing literature. Some statements—particularly those on the origins of the various species of trouts—will be questioned by both biologists and knowledgeable fishermen. The chapter on trout flies shows ties by a few custom tyers, but one wonders why only these few tyers are featured. The concluding section on "Source of Flies and Fly-Tying Materials" will become outdated fairly rapidly and, for California at least, is incomplete.

Although the book has the above shortcomings, I feel these are outweighed by the excellence of the many color photographs of fish and flies and the diagrams illustrating the various types of casts. The text is clear, and interesting, particularly the section on casting techniques. Of the books available today for the beginning fly fisherman, this would rank as one of the best; it would also be of interest to the more advanced fly fisherman interested in perfecting his techniques.—*K. A. Hashagen, Jr.*

The Steelhead Trout

By Trey Combs, Northwest Salmon-Trout-Steelheader Company, P. O. Box 02112 Portland, OR 97202, 1971; 187 p., illustrated. $5.95.

The complete title of this book—*The Steelhead Trout—Life History, Early Angling and Contemporary Steelheading*—summarizes the contents of this excellent little book. The life history portion pulls together all the important steelhead studies including the work by Shapovalov and Taft at Waddell Creek, and discusses them clearly and intelligently. Summer run, winter run, distribution and size along the west coast and variations found in the major drainages are among the material presented.

The middle section covers the discovery of the steelhead as a sport fish and the early history of fishing for this important game fish.

The final portion describes the development of the specialized rods, lines, and lures necessary to take steelhead, the methods of fishing (fly, spin, plunking, and drifting), and closes with a dictionary of steelhead fly patterns and an excellent chapter on the future of the steelhead. The author obviously knows his subject thoroughly, and the pleasure he derives from steelheading comes through as clearly as his concern for the steelhead.

The book is available in California only by mail from Northwest Salmon-Trout-Steelheader Co., and, in my opinion, is well worth the $5.95 price tag.—*K. A. Hashagen, Jr.*

Fly-Tying Problems and Their Answers

By John Veniard and Donald Downs; Crown Publishers, Inc., New York. 1972. 124 p. illustrated. $4.95.

The fly-tying problems encountered in this book are problems which confront the beginner fly-tyer, the proper application of quill wings and hackle, the proper construction of dubbed, tinsel, herl and hair bodies, and the whip finish. The chapters on hook terminology, tying silks and fly-tying terminology also apply to the beginner or to anyone who has not really mastered the basics. For the more advanced tyer there are instructions for tying parachute hackles, extended bodies, tandem hook mounts and methods of "improving" materials. Stiffening dry fly hackle, making substitutes for rare hackles, and preparing golden pheasant crests are a few of the methods of "improvement" discussed.

Mr. Veniard's explanations are extremely clear, particularly when they are combined with Mr. Downs excellent drawings. Usually two or more alternate solutions to a problem are offered, leaving it to the reader to pick the one most suited to his tying style. *Fly-tying Problems and Their Answers* is an excellent reference for any serious fly-tyer's library and it is reasonably priced at $4.95—*K. A. Hashagen, Jr.*

The Way of a Trout

By R. P. Van Gytenbeek; J .B. Lippincott Co., Philadelphia and New York, 1972. viii + 146 p. illustrated. $8.95.

The Way of a Trout was adapted from the Trout Unlimited film by the same name. The first part of the book chronicles the life of a trout, using stills from the movie. Text by Albert Hazzard, well known University of Michigan fisheries biologist, accompanies the excellent underwater photography of James Wilkie. The second part of the book, by Van Gytenbeek, describes the problems involved in conserving the habitat necessary for trout. A series of chapters outline "The Enemy" (Corps of Engineers, Bureau of Reclamation, TVA, and the Forest Service), "Know the Facts, Laws, and Alternatives". Successful Trout Unlimited actions are used to illustrate each of the chapters. The second part does a good job of explaining Trout Unlimited, its goals, and methods (cooperate, conserve, and organize). The one drawback to the book, in my opinion, is the one paragraph on Hat Creek, Shasta County, California. The description of this one project is boldly pro-Trout Unlimited and several of the statements are incorrect.—*K. A. Hashagen, Jr.*

Practical Fishing Knots

By Lefty Kreh and Mark Sosin; Crown Publishers, Inc., New York. 1972. vii + 160 p. illustrated. $5.95.

If you're a fisherman and want to learn the proper knot for each situation, this is the book. Excellent photograph and line drawings illustrate each step of the tying of a knot, splice, or snell. A brief explanation is given for each knot, describing the best use for the knot (tying line to lure, line to line, line to wire, etc.), and its breaking strength. Approximately 50 knots are discussed, including knots for the boater, the fly, spin, bait, or troll fisherman, and the big game fisherman with his wire leaders. Because nearly all fishermen use monofilament, the authors have included an excellent introductory chapter on monofilament which includes a discussion of deterioration, line strength, knot strength, limpness versus stiffness, stretch, and moisture. Many misconceptions about this type of line are corrected.—*K. A. Hashagen, Jr.*

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Notice is hereby given that the Fish and Game Commission shall meet on April 6, 1973, at 9:00 a.m. in Room 1138 of the New State Building, 107 South Broadway, Los Angeles, California, to receive recommendations from its own officers and employees, from the Department of Fish and Game and other public agencies, from organizations of private citizens, and from any interested person as to what, if any, orders should be made relating to birds or mammals, or any species or variety thereof for the 1973 hunting season.

Notice is hereby given that the Fish and Game Commission shall meet at 9:00 a.m. on April 27, 1973, in the Board of Supervisors Chambers, County Courthouse, Redding, California, for public discussion of and presentation of objections to, the proposals presented to the Commission on April 6, 1973, and after consideration of such discussion and objections the Commission shall publicly announce the regulations it proposes to make relating to birds or mammals, or any species or variety thereof, for the 1973 hunting season.

Notice is hereby given that the Fish and Game Commission shall meet on May 25, 1973, at 9:00 a.m. in the Auditorium of the Resources Building, 1416 Ninth Street, Sacramento, California, to hear and consider any objections to its determinations or proposed orders in relation to birds and mammals for the 1973 hunting season, such determinations resulting from hearing held on April 27, 1973. This notice is published in accordance with the provisions of Section 206 of the Fish and Game Code.

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